Risk Assessment Work Plan

Salt Chuck Mine Remedial Investigation

Tongass National Forest, Alaska

Prepared for

U.S. Environmental Protection Agency
Region 10

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Prepared by

CH2MHILL

AES10

Architect and Engineering Services Contract

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Acronyms and Abbreviations

°F	degrees Fahrenheit
µg/dL	micrograms per deciliter
$\mu g/m^3$	micrograms per cubic meter
µg/mg	microgram per milligram
ABS	absorption fractions
ABS_{GI}	Gastrointestinal absorption efficiency
ADAF	Age Dependent Adjustment Factors
ADNR	Alaska Department of Natural Resources
AET	apparent effects threshold
AF	Skin adherence factor
ALM	Adult Lead Model
AT	Averaging time
ATSDR	Agency for Toxic Substances and Disease Registry
AUF	area use factor
BAF	bioaccumulation factor
BAFL	Diet-to-animal tissue lipid bioaccumulation factor
BCF	bioconcentration factor
BERA	baseline ecological risk assessment
bgs	below ground surface
B_{ij}	Constituent concentration (j) in biota type (i)
BW	body weight
BW_a	adult body weight
BW_c	child body weight
CAEPA	California Environmental Protection Agency
CF	conversion factor
cfs	cubic feet per second
cm/hour	centimeters per hour
cm^2	square centimeter
COPC	Chemical of potential concern
COPEC	chemical of potential ecological concern
C_p	Constituent concentration in wild plants
cPAH	carcinogenic polynuclear aromatic hydrocarbon
C_S	Constituent concentration in soil or sediment
CSM	conceptual site model
C_{sw}	Constituent concentration in surface water
C_T	Constituent concentration in shellfish tissue
C_W	Constituent concentration in surface water
DA_{event}	Absorbed dose per event
DQO	data quality objective
EC	exposure concentration
EC_a	Exposure concentration in air
Eco-SSL	U.S. EPA Ecological Soil Screening Level
ED	Exposure duration
ED_a	Adult exposure duration
ED_c	Child exposure duration
EE/CA	Engineering Evaluation/Cost Analysis
EF	Exposure frequency
E_j	Estimated COPEC exposure *or* Total exposure

ELCR	excess lifetime cancer risk
EPA	U.S. Environmental Protection Agency
EPC	exposure point concentration
EPI	Estimation Program Interface
ERA	ecological risk assessment
ER-M	effects range-median
ESV	ecological screening value
ET	Exposure time
F	Fraction of game animal diet originating from site
FCV	freshwater chronic value
FIR	Total food ingestion rate for the representative species
Forest Service	United States Department of Agriculture, Forest Service
FR_x	Foraging range for target species x
g/day	grams per day
HHRA	human health risk assessment
HQ	hazard quotient
HQ_{inh}	Noncancer hazard quotient from inhalation
hr/event	hour per event
IEUBK	Integrated Exposure Uptake Biokinetic
IFP_{adj}	Age-adjusted plant ingestion factor
Intake	Chronic daily intake averaged over a lifetime
IRIS	Integrated Risk Information System
IRP_a	Adult wild plant ingestion rate
IRP_c	Child wild plant ingestion rate
IR_S	Soil or sediment ingestion rate
IR_t	Shellfish tissue ingestion rate *or* wild game ingestion rate
IR_W	Surface water ingestion rate
IUR	Inhalation unit risk
kg	kilogram
kg_{diet}/kg_{bw}-day	kilograms diet per kilograms body weight per day
K_p	Dermal permeability coefficient
L/ kg_{bw}-day	liters per kilograms body weight per day
L/day	liters per day
LOAEL	lowest observed adverse effect level
LT	Fraction of game animal tissue as lipid
m^3/kg	cubic meters per kilogram
MDL	method detection limits
MF	migration factor
mg/ cm^2	milligrams per square centimeter
mg/cm^2-event	milligrams per square centimeter per event
mg/cm^3	milligrams per cubic centimeter
mg/day	milligrams per day
mg/kg	milligrams per kilogram
mg/kg_{bw}/day	milligrams per kilograms body weight per day
mg/kg-day	milligrams per kilograms per day
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mg-year/kg-day	milligrams per year per kilograms per day
MRL	Minimal Risk Level
N	Number of chemicals
NAWQC	U.S. EPA National Ambient Water Quality Criteria

NHPA	National Historic Preservation Act
NOAA	National Oceanic and Atmospheric Association
NOAEL	no observed adverse effect level
ORNL	Oak Ridge National Laboratory
PAH	polynuclear aromatic hydrocarbon
PEC	probable effect concentration
PEF	particulate emission factor
PGE	platinum group element
P_i	Proportion of biota type (i) in diet
P_p	Proportion of animal diet as wild plants
PPRTV	U.S. EPA Provisional Peer Reviewed Toxicity Value
P_s	Proportion of diet as incidentally ingested soil
RAGS	Risk Assessment Guidance for Superfund
RAWP	Risk Assessment Work Plan
RfC	reference concentration
RfD	reference dose value
RfD_{ABS}	Absorbed reference dose
RfD_i	Reference dose of the ith chemical
RfD_o	Oral reference dose
RI/FS	Remedial Investigation/ Feasibility Study
Risk	Excess lifetime cancer risk
$Risk_i$	Cancer risk for the ith chemical
$Risk_{inh}$	Excess lifetime cancer risk from inhalation
$Risk_T$	Total cancer risk from route of exposure
RME	reasonable maximum exposure
SA	Exposed skin surface area
SF	slope factor
SF_{ABS}	Absorbed slope factor
SF_o	Oral slope factor
S_j	Constituent concentration in soil/sediment
SLERA	screening level ecological risk assessment
SMDP	Scientific Management Decision Point
SQuiRT	NOAA Screening Quick Reference Table
SSL	Soil Screening Level
T&E	Threatened and endangered
TEC	threshold effect concentration
TEF	toxicity equivalency factor
t_{event}	Event duration
TRV	toxicity reference value
USBLM	Bureau of Land Management
USFWS	U.S. Fish and Wildlife Service
VF	Volatilization factor
$Water_j$	Constituent concentration in water
WIR	Total water ingestion rate for the representative species
yd^3	cubic yard

1. Introduction

This Risk assessment Work Plan (RAWP) describes the approach to be used in preparing the baseline risk assessment for the Salt Chuck Mine remedial investigation/feasibility study (RI/FS) being conducted by the U.S. Environmental Protection Agency (EPA) in Tongass National Forest, Alaska. Salt Chuck Mine was added to the EPA National Priorities List on March 4, 2010. The site is an inactive former copper, gold, silver, and platinum group elements (PGEs), most notably palladium mine located on Prince of Wales Island in the Tongass National Forest at the northern end of Kasaan Bay, Alaska (Figure 1).

This RAWP meets requirements of the RI/FS Work Plan Amendment 1, Revision 0 for Salt Chuck Mine, Task Order TBD-RI-FS-10GK, Region 10 AES Contract No. 68-S7-04-01, which stipulates that a risk assessment shall be conducted as part of the RI/FS at Salt Chuck Mine, and in accordance with CERCLA.

1.1 Purpose of the Risk Assessment

The baseline risk assessment will seek to determine the nature, magnitude, and probability of actual or potential harm to public health, safety, or welfare, or to the environment, posed by the threatened or actual release of hazardous substances. Two components will comprise the risk assessment: a human health risk assessment (HHRA) and an ecological risk assessment (ERA). The assessment will identify and characterize the toxicity of chemicals of potential concern (COPCs), potential exposure pathways, potential human and ecological receptors, and the likelihood and extent of impact or threat under current and reasonably anticipated future land use conditions at the site.

The results of the risk assessment will provide, with consideration of other factors, a basis for risk management decisions. Based on the magnitude of risks posed by the site, the overall objective of the risk assessment will be to identify which one of three decisions is most appropriate: (1) proceed with an evaluation of remedial options; (2) proceed with a No Further Action determination; or (3) acquire additional site characterization data to address residual uncertainties and further refine the conceptual site model (CSM) and risk assessment.

1.2 Organization of this Work Plan

This RAWP includes the following components:

- **Section 1, Introduction.** Provides the objectives of the risk assessment and organization of the RAWP.
- **Section 2, Conceptual Site Model.** Describes the site characteristics and history, hydrology, ecological setting, and land and water uses, and identifies the pathways by which human and ecological exposures could occur.
- **Section 3, Data Usability and Processing.** Describes the process for evaluating data usability for the risk assessment.
- **Section 4, Human Health Risk Assessment Methodology.** Provides the approach that will be used for the human exposure assessment, toxicity assessment, and risk characterization.
- **Section 5, Ecological Risk Assessment Methodology.** Provides the approach that will be used to evaluate ecological exposures and effects, and for characterizing risk to ecological receptors.
- **Section 6, Risk Assessment Report.** Describes the report containing the HHRA and ERA
- **Section 7, References.** Provides citations from this RAWP

Streams/Creek

100-foot Contour Line (TNF)

Glory Hole

Mine Waste Type

Waste Rock Pile

Waste Rock Pile and Tailings

Tailings

N

0 2,000 4,000 Feet

Notes:
(1) Aerial photography courtesy US Census Bureau; approximate date 2006. NAD83, UTM Zone 8N, Meters. Pixel size 1 meter.
(2) Source Documents: Figures 2-2 and 2-3, URS, Salt Chuck Mine Report, March 2010. Features: C-Series, D-Series, Mean High Tide, Stream, with modifications based on site observations from 2012 RI investigation.
(3) TNF = Tongass National Forest

Figure 1
Location and Site Features
Risk Assessment Work Plan
Salt Chuck Mine, Alaska

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EPA

2. Conceptual Site Model

This section describes the potential exposure pathways for contaminants believed to be potentially associated with the Salt Chuck Mine, based on currently available site information. The CSM is formulated according to applicable guidance, with the use of professional judgment and site-specific information on contaminant sources, release mechanisms, routes of migration, potential exposure points, potential routes of exposure, and potential receptor groups associated with the site. The CSM provides a framework for understanding conditions and physical processes which influence the potential for risk. The CSM describes the following:

- **Sources** of chemicals of potential concern.
- **Pathways** describing the physical mechanism through which a chemical could come into contact with receptors (i.e., potentially exposed humans or wildlife).
- **Receptors** comprised of human or ecological populations potentially exposed to the chemicals of potential concern.

There must be a complete exposure pathway from the source of chemicals in the environment (in soil, groundwater, air, sediment, surface water, or biota) to human or ecological receptors for chemical intake to occur. In the absence of any one of these components, an exposure pathway is considered incomplete and by definition, there is no risk or hazard.

Preliminary human health and ecological conceptual exposure models for Salt Chuck Mine were originally presented in Figures 2-9 and 2-10 in the *Draft Quality Assurance Project Plan Salt Chuck Mine Remedial Investigation, Tongass National Forest, Alaska* (CH2M HILL, 2012a). These exposure models have been updated to reflect current understanding of sources, pathways, and receptors at the Salt Chuck Mine site, which are described below.

2.1 Site Description

Salt Chuck Mine is located approximately 4½ miles south-southwest of Thorne Bay, Alaska, at the northern end of Kasaan Bay, on Prince of Wales Island (Figure 1). The mine is located in the Tongass National Forest, Outer Ketchikan County, within Township 72 South, Range 84 East, Sections 16 and 17, Copper River Meridian, Alaska. Salt Chuck Bay, from which the mine takes its name, is a shallow, restricted water body bordering the mine site to the south and forms the northernmost arm of Kasaan Bay (Figure 1). The Salt Chuck Mine site is accessible by water or by road, the last ½-mile of which is newly constructed and remains gated. Thorne Bay (population 471) is the closest year-around population, and is accessible from the site by road. The Organized Village of Kasaan (Kasaan, population 49) is the nearest community by water and is located about 9 miles southeast of the site on the eastern side of Kasaan Bay.

For the purposes of the RI, the Salt Chuck Mine site includes both the upland areas that lie on lands managed by the United States Department of Agriculture, Forest Service (Forest Service) and those adjacent areas and impacted environments within State-owned tidelands (referred to as the intertidal zone in this RAWP).

The upland area includes the former mill site and associated features (former buildings, above-ground storage tank, drum storage area, electric locomotive batteries, etc.) as well as other mine-related features not directly at the mill site (upland tailings piles, waste rock piles, tramways, adit, glory hole, etc). The upland area consists of remnants of at least 25 structures and 13 waste rock piles and two main tailing deposits. Remains of buildings and waste rock piles are located near the beach, along the tramway leading from an adit to the mill, upstream along the unnamed stream that flows past the adit portal, and near the glory hole. The mine openings are uphill and approximately ½-mile from the mill area. Part of the west side of the Salt Chuck Mine upland area is bordered by Lake Ellen Creek, which originates from Lake Ellen located west of the site.

The intertidal zone, as defined by the area below mean high tide, encompasses approximately 80 acres south of the mill site, and extends around an unnamed island in the middle of Salt Chuck Bay. Much of the intertidal zone is covered by fucus, gravel, mollusk shell fragments, and beach grasses, but areas closest to the former mill site consist of mud flats mixed with tailings, with little vegetation. The main tailings pile is comprised of roughly 100,000 cubic yards (yd^3) of material located primarily in the intertidal zone south and southeast of the mill. This main tailing pile and the adjacent upland tailings deposits, together cover an area of approximately 23 acres. The saturated intertidal tailings are not contained in a manner that prevents contaminants within the tailings from migrating into the waters of Salt Chuck Bay.

2.1.1 History

The first claims at Salt Chuck Mine were staked in 1905, when the mine was originally was known as the Goodro Mine (Bureau of Land Management [BLM], 1998). The mine and mill operated from 1905 to 1941 and processed over 326,000 tons of ore. The primary ores produced from the mine were copper, gold, silver, and platinum group elements, most notably palladium. Salt Chuck Mine was the most important copper producer in the Ketchikan Mining District, the only single lode palladium mine in Alaska, and of national importance as a palladium producer in the 1920s. The discovery that the ore contained palladium/platinum led to construction of the mill with a capacity of processing 30 tons of ore per day in 1917, and expanded to a capacity of 300 tons per day in 1923.

Considerable historic mining activity has occurred in the mineral-rich region where the Salt Chuck Mine site is located (Maas et al., 1995). Nearby historic mines include the Rush and Brown Mine located on the west slope of Lake Ellen, the Venus Mine located about 1-1/2 miles southwest of the site, in an area that drains southward into Karta Bay, and the Haida Mine located northeast of Browns Bay about 2-1/2 miles southeast of the site. Pure Nickel, Inc. currently holds active mining claims covering about 2,700 acres at and near the Salt Chuck Mine site.

2.1.2 Climate

Climatological data recorded by the National Oceanic and Atmospheric Administration (NOAA) at the weather station in Craig (about 25 miles southeast of the mine site) indicates that the annual precipitation in that area was 84, 94, and 105 inches in 2009, 2010, and 2011, respectively. The climate summary for Craig is provided in Table 1. The rainy season occurs in fall and early winter (NOAA National Climate Data Center, 2012). Of this, up to about 25 inches of snow fall per year. The average annual temperature is about 45 degrees Fahrenheit (°F). July and August are the warmest months, with average high temperatures in the upper-50s (°F), and January and February are typically the coldest months, with average low temperatures in the upper-30s (°F). In 2009, there were 97 days with reported temperatures below freezing. Daylight changes from 15 ½ hours on the longest day of the year to about 7 hours on the shortest. It should be noted that the Thorne Bay side of the island where the mine site is gets appreciably more precipitation than the Craig side.

2.2 Site Hydrology

Surface water flows from the upland portion of the Salt Chuck Mine site include those from the main adit, a small unnamed stream, and Lake Ellen Creek (Figure 1). Water also discharges from shallow groundwater originating from the upland mine areas and the former mill site. Salt Chuck Bay is the ultimate receiving body for all of these flows.

2.2.1 Adit Discharge

Surface water runoff in the upper portion of the Salt Chuck Mine site enters the glory hole at the 300-foot elevation and drains into the haulage level of the main adit. The discharge from the main adit portal is believed to result when water collecting within the glory hole mixes with groundwater percolating through bedrock fractures, collects behind rock and debris near the adit portal, then discharges from the portal at an estimated flow rate of <0.1 cubic feet per second (cfs) (URS, 2007).

2.2.2 Unnamed Stream

A small, unnamed stream (Unnamed Stream), originating northeast of the site from Power Lake cuts across the upland areas of Salt Chuck mine and also receives discharge from the adit. During higher flow events, overflows near the adit portal flow both west down the normal drainage and south along the rail line. The rail line overflow diverges from the track after approximately 100 feet then flows westerly, rejoining the Unnamed Stream. The

Unnamed Stream continues to flow south and discharges into the head of Salt Chuck Bay about 300 feet west of the former mill site. The flow rate ranges from less than 1 to about 10 cfs in the stream, varying directly with precipitation conditions. Wetland areas exist along the entire length of the stream.

Once discharging into the intertidal area, at low tide the Unnamed Stream continues to flow along the west side of the tailings pile and merges with the Lake Ellen Creek before entering Salt Chuck Bay.

2.2.3 Lake Ellen Creek

Lake Ellen Creek originates from Lake Ellen 0.5 miles west of the mine site, flowing around the western portion of the mine site then into Salt Chuck Bay. At low tide, Lake Ellen Creek merges with the unnamed stream southwest of the tailings pile before entering Salt Chuck Bay (Figure 1). Estimated average flow in Lake Ellen Creek is approximately 15 to 20 cfs, based upon observations made by BLM personnel during the 1997 Removal Preliminary Assessment (BLM, 1998).

2.2.4 Salt Chuck Bay

An intertidal zone encompassing approximately 80 acres is located south of the mill site, and extends around an unnamed island in the middle of Salt Chuck Bay (Figure 1). At high tide, saltwater from Salt Chuck Bay inundates the lower portions of Lake Ellen Creek, the unnamed stream, and the main tailings pile. The streams, tailings, and outlying sediment are exposed at low tide. Maximum tidal ranges in the Kasaan Bay area are typically on the order of 18 to 23 feet (NOAA, 2002). At highest high tides, saltwater is expected to be on the order of 3 to 9 feet above the seafloor near the mouth of Lake Ellen Creek. The bench that the mill sits on is roughly 6 to 10 feet above the highest tide line.

2.3 Ecological Setting

The Kasaan Peninsula is a long mountainous ridge with steep, heavily timbered slopes. The upland area of the Salt Chuck Mine site is characterized by gently rolling hills, dense vegetation, and bedrock (BLM, 1998). The habitat consists of wet coastal rain forest common to Southeast Alaska. Vegetation is typical of Southeast Alaska where forested areas are dominated by Sitka spruce (*Picea sitchensis*) and western hemlock (*Tsuga heterophylla*), with some western red cedar (*Thuja plicata*), yellow cedar (*Chamaecyparis nootkatensis*), shore pine (*Pinus contorta*), and alder (*Alnus rubra*) intermixed with abundant berry bushes, devil's club, and small scrub shrubs. Species of plants, invertebrates, fish, birds, and mammals common to Southeast Alaska and which may be present in the site area are listed in Tables 2 through 5.

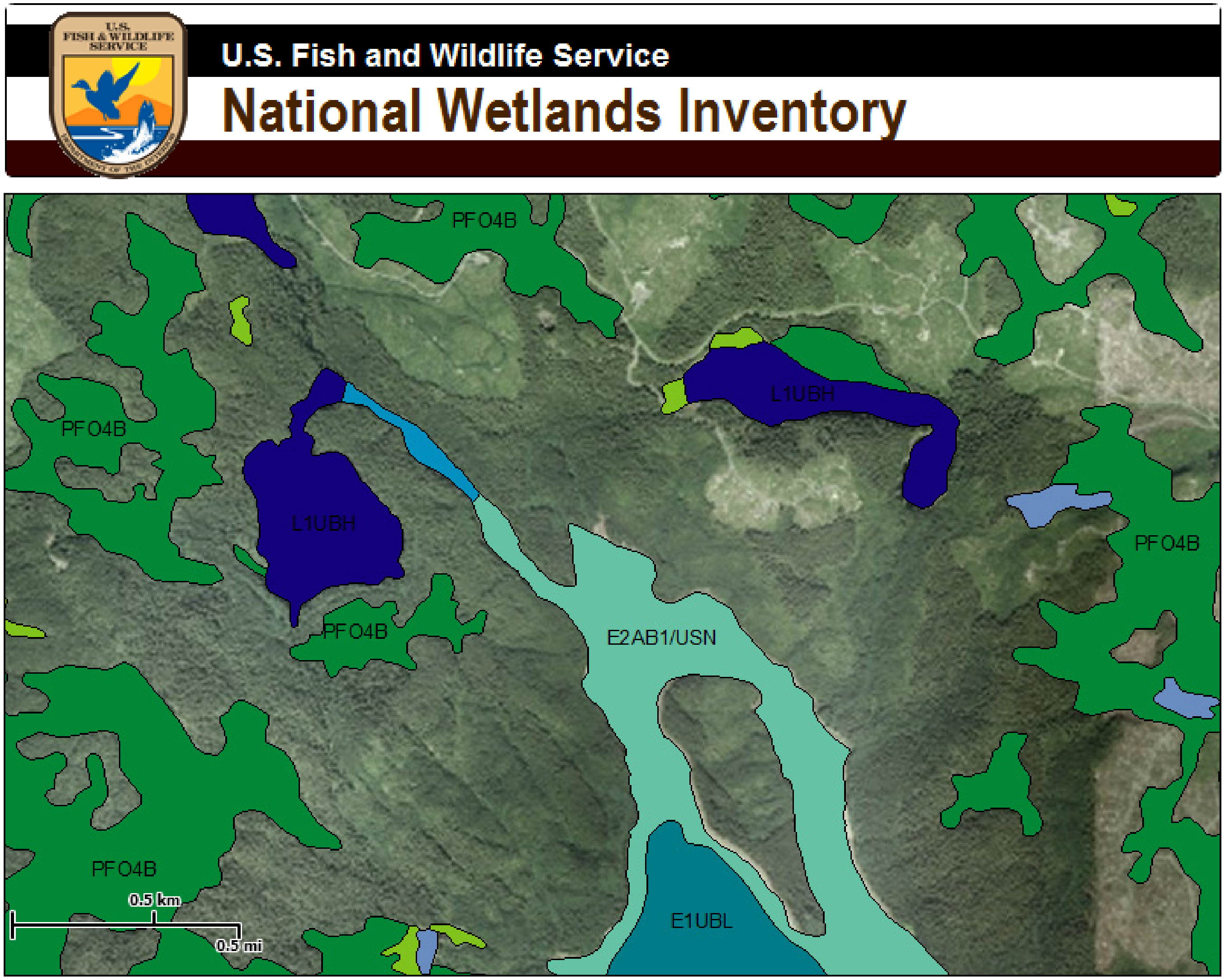
2.3.1 Wetlands

Figure 2 shows the locations of wetland area in the general vicinity of the Salt Chuck mine site, as identified by the US Fish and Wildlife Service National Wetlands Inventory (USFWS, 2012). Lake Ellen Creek is classified as riverine, tidal, with an unconsolidated bottom and permanent tidal wetland. The higher beach areas are classified as estuarine intertidal, emergent, and persist in a tidal regime that is irregularly flooded. The intertidal area is classified as regularly flooded, with sand and gravel flats and aquatic beds-algae (BLM, 1998). Freshwater forested wetland areas are present along the entire length of the Unnamed Stream that bisects the mine site (Figure 1).

2.3.2 Aquatic Life

Lake Ellen Creek is considered an anadromous fish stream that may support pink, coho, and chum salmon, dolly varden, and steelhead (BLM, 1998). During low tide, several salmon were also observed in the lower portion of the Unnamed Creek adjacent to the intertidal tailings pile, during the 2011 sampling event. According to the Alaska Department of Natural Resources (ADNR), Karta Bay and Salt Chuck Bay are unique areas with high fish and wildlife habitat and harvest values and recreation values. Karta Bay, adjacent and downstream to Salt Chuck Bay, is an important community sockeye salmon harvest area (ADNR, 1998).

Wetlands Near Salt Chuck Mine



Wetlands

- Freshwater Emergent
- Freshwater Forested/Shrub
- Estuarine and Marine Deepwater
- Estuarine and Marine
- Freshwater Pond
- Lake
- Riverine
- Other

This map is for general reference only. The US Fish and Wildlife Service is not responsible for the accuracy or currentness of the base data shown on this map. All wetlands related data should be used in accordance with the layer metadata found on the Wetlands Mapper web site.

FIGURE 2
National Wetlands Inventory Map
Salt Chuck Mine Remedial Investigation
Risk Assessment Work Plan

Source: US Fish and Wildlife Service Wetlands Mapper, October 3, 2012

The intertidal areas within Salt Chuck Bay support an abundance of shellfish and contain a diverse assemblage of seaweeds and marine invertebrates, including blue mussels, little neck clams, softshell clams, butter clams, cockles, barnacles, snails, shrimp, starfish, and crabs. Lower invertebrate diversity is seen closer to the Salt Chuck Mine site in the southern part of the intertidal tailings deposit, which supports a significant population of marine worms, but is almost devoid of shellfish.

Kasaan Bay, located downstream from Salt Chuck Bay and Karta Bay, supports abundant fish and wildlife. Several areas along the west side of Kasaan Bay, downstream of Karta Bay are classified as crucial habitat for herring spawning and salmon rearing and schooling. Twelvemile Arm flows southwest from the upper portion of Kasaan Bay and supports several anadromous fish streams designated as crucial habitat for salmon rearing and schooling.

2.3.3 Wildlife

ADNR designates Salt Chuck and Karta Bays as *Crucial Habitat (Ha)* for seasonal black bear concentrations, seasonal waterfowl concentrations, herring spawning, and salmon rearing and schooling (ADNR, 1998). Sitka black-tailed deer, black bear, wolf, and mink tracks were observed on the intertidal tailings area south of the Salt Chuck Mine site during the 2011 and 2012 investigation activities. Numerous species of birds were also observed both along the shoreline and in the rainforest canopy, including seabirds (e.g., cormorants), shore birds (e.g., sandpipers), bald eagles, belted kingfishers, ravens, waterfowl (e.g., Canada geese), and a variety of passerines (e.g., chickadees). Species of birds and mammals common to Southeast Alaska that may occur on Prince of Wales Island are listed in Tables 4 and 5.

2.3.4 Threatened and Endangered Species

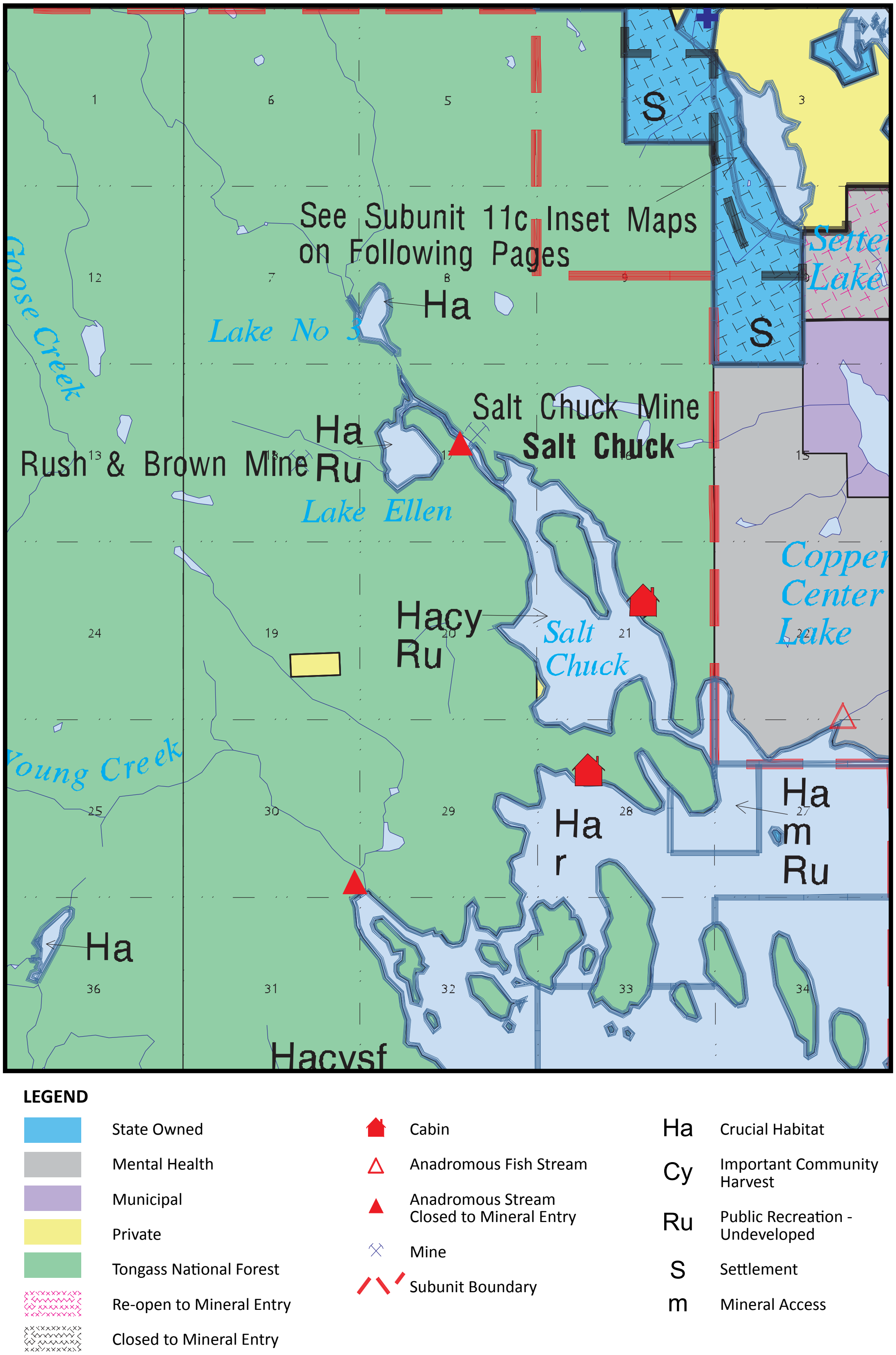
No designated habitat for Threatened and Endangered Species (T&E) has been identified at the site, and no sensitive environmental areas have been designated by the Alaska Coastal Management Program near the site (BLM, 1998). The only federally designated T&E species visiting the Prince of Wales Island area is the humpback whale (BLM, 1998). The humpback whale is a transient visitor to the general area, as is the Steller sea lion. There are no designated sea lion haulouts near Karta Bay.

2.4 Current and Reasonably Anticipated Land Uses

Current and reasonably anticipated future land uses are used to identify potentially exposed populations and to determine exposure patterns for the environmental media at the site, including soil, groundwater, air, sediment, surface water, or biota.

The land use status for the lands on and surrounding the Salt Chuck Mine site are shown on Figure 3. The Salt Chuck Mine area is designated as an undeveloped area of intensive public recreation use by the Alaska Department of Natural Resources (ADNR, 1998) *Prince of Wales Island Area Plan*. Salt Chuck Bay is an excellent protected waterway for canoes, kayaks, and other small boats, and passage from Salt Chuck Bay to Lake Ellen is possible by these smaller watercraft during high flows and tides. The Salt Chuck Mine site in general is accessible by road (via Forest Service locked gate), trail, boat, of float plane. Forest service roads extend past the north end of the mine site, and are used by hunters and casual recreational vehicle traffic. There is a marked trailhead located along the Forest Service road about 0.5 miles north of the glory hole. This hiking trail extends 1.1 mile along the banks of Ellen Creek down to the mouth of the Unnamed Stream and to the former mill site.

Recreational users include hunters, hikers, boaters, anglers, rock climbers, gatherers (e.g., berry, mushroom, and sea asparagus pickers), clam diggers, trappers, etc. The glory hole at the Salt Chuck Mine is known to be used by rock climbers for rappelling. A Forest Service campground is located about 1.2 miles northwest of the site at Lake No.3. In addition, a recreational public cabin is located on Forest Service land at the mouth of the Karta River about five miles south of the site. The nearest public access boat ramp to the site is located in Kasaan, about 10 miles southeast of the site. Although there are no dock facilities at the mine site, the upper end of Salt Chuck Bay is accessible during high tide by small craft. However, the road system and trail extending from the glory hole to the mill make access by land the most common access.



Source: Alaska Department of Natural Resources, Division of Mining, Land, and Water, 1998. Prince of Wales Island Area Plan, 1998. Originally adopted June 1985; revised October 1998.

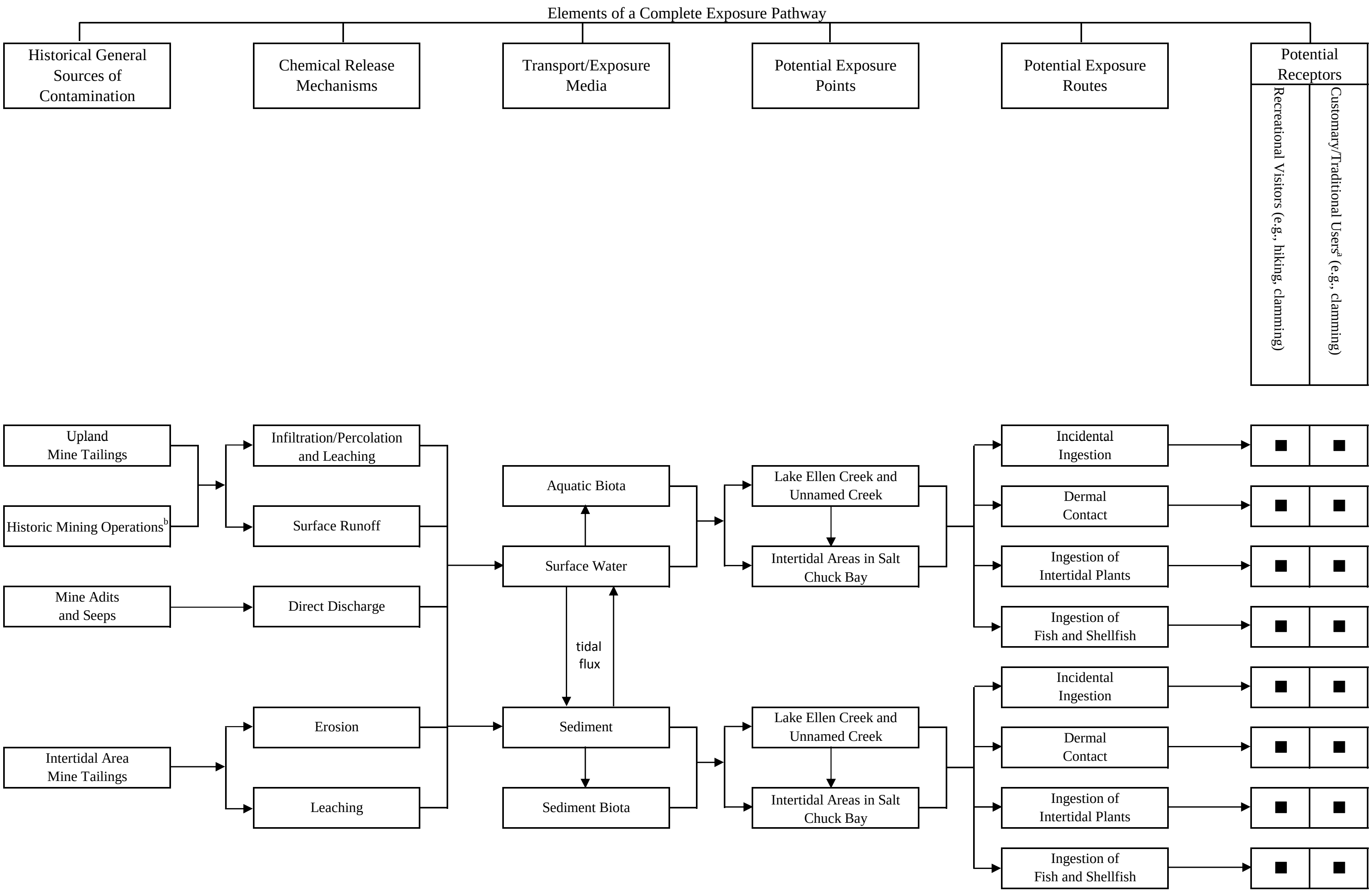
FIGURE 3
Land Use Status in the Vicinity of Salt Chuck Mine
Salt Chuck Mine Remedial Investigation
Risk Assessment Work Plan

FIGURE 4

Conceptual Site Model for Potential Human Exposures for the Intertidal Areas

Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Risk Assessment Work Plan



Notes:

■ = Potentially complete pathway

□ = Pathway considered minor

Blank = Incomplete pathway

a. This scenario generally addresses individuals who include natural food sources in their diet, either in part or in total, by hunting, fishing, and/or gathering native food for consumption.

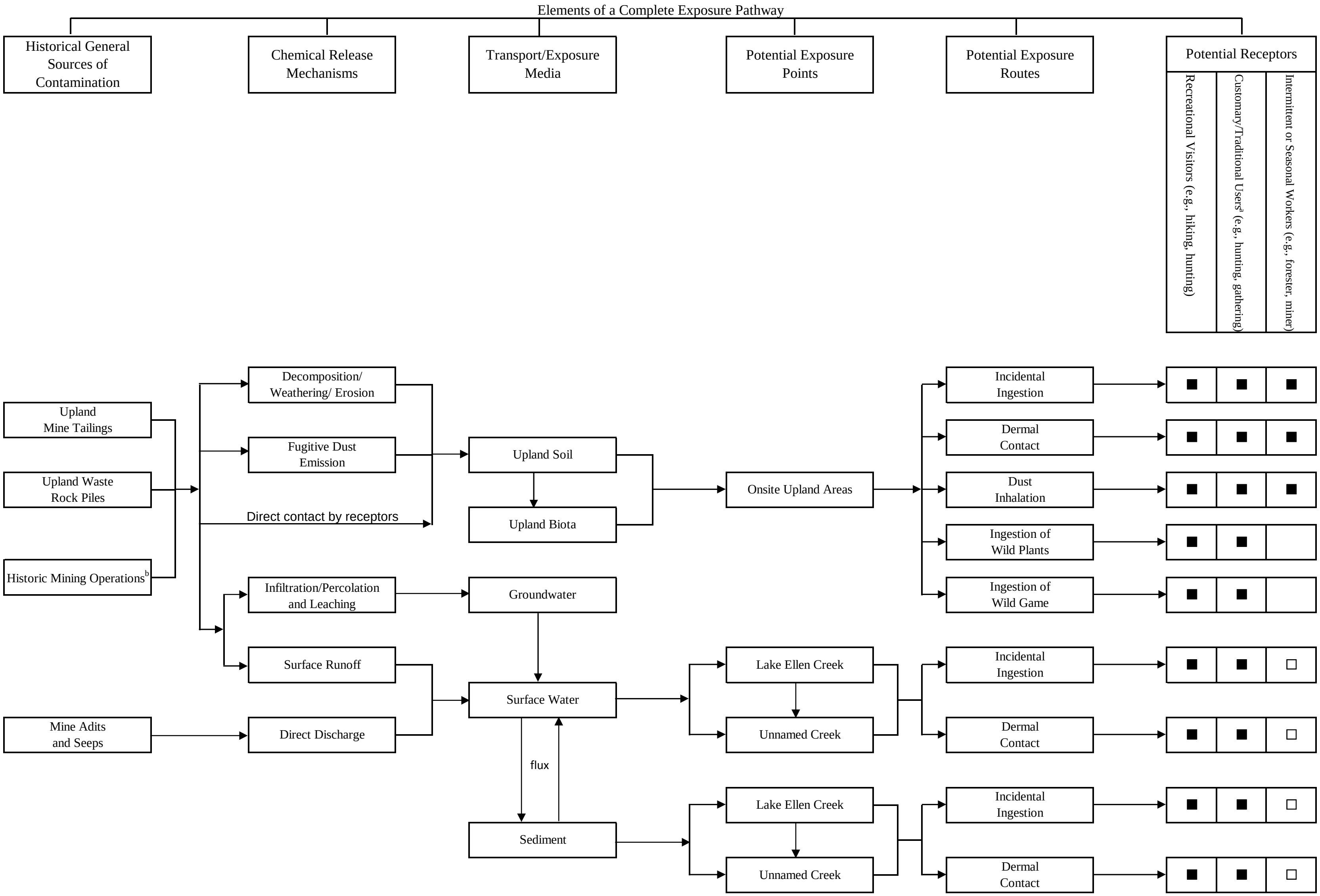
b. Includes aboveground fuel storage tanks, battery banks, and other upland sources associated with historic mining operations.

FIGURE 5

Conceptual Site Model for Potential Human Exposures for the Upland Areas

Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Risk Assessment Work Plan



Notes:

■ = Potentially complete pathway

□ = Pathway considered minor

Blank = Incomplete pathway

a. This scenario generally addresses individuals who include natural food sources in their diet, either in part or in total, by hunting, fishing, and/or gathering native food for consumption.

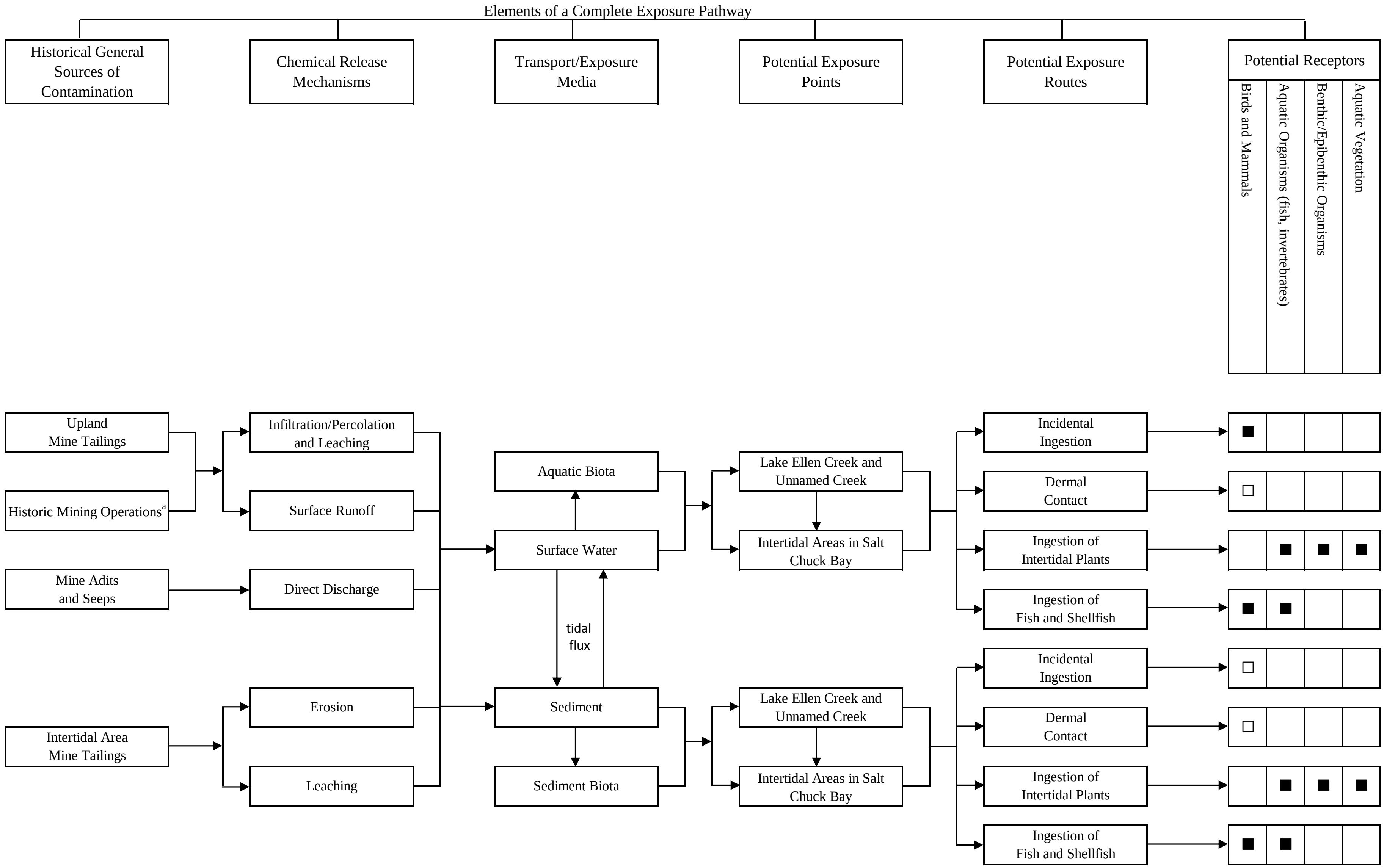
b. Includes aboveground fuel storage tanks, battery banks, and other upland sources associated with historic mining operations.

FIGURE 6

Conceptual Site Model for Potential Ecological Exposures for the Intertidal Areas

Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Risk Assessment Work Plan



Notes:

■= Potentially complete pathway

□= Pathway considered minor

Blank = Incomplete pathway

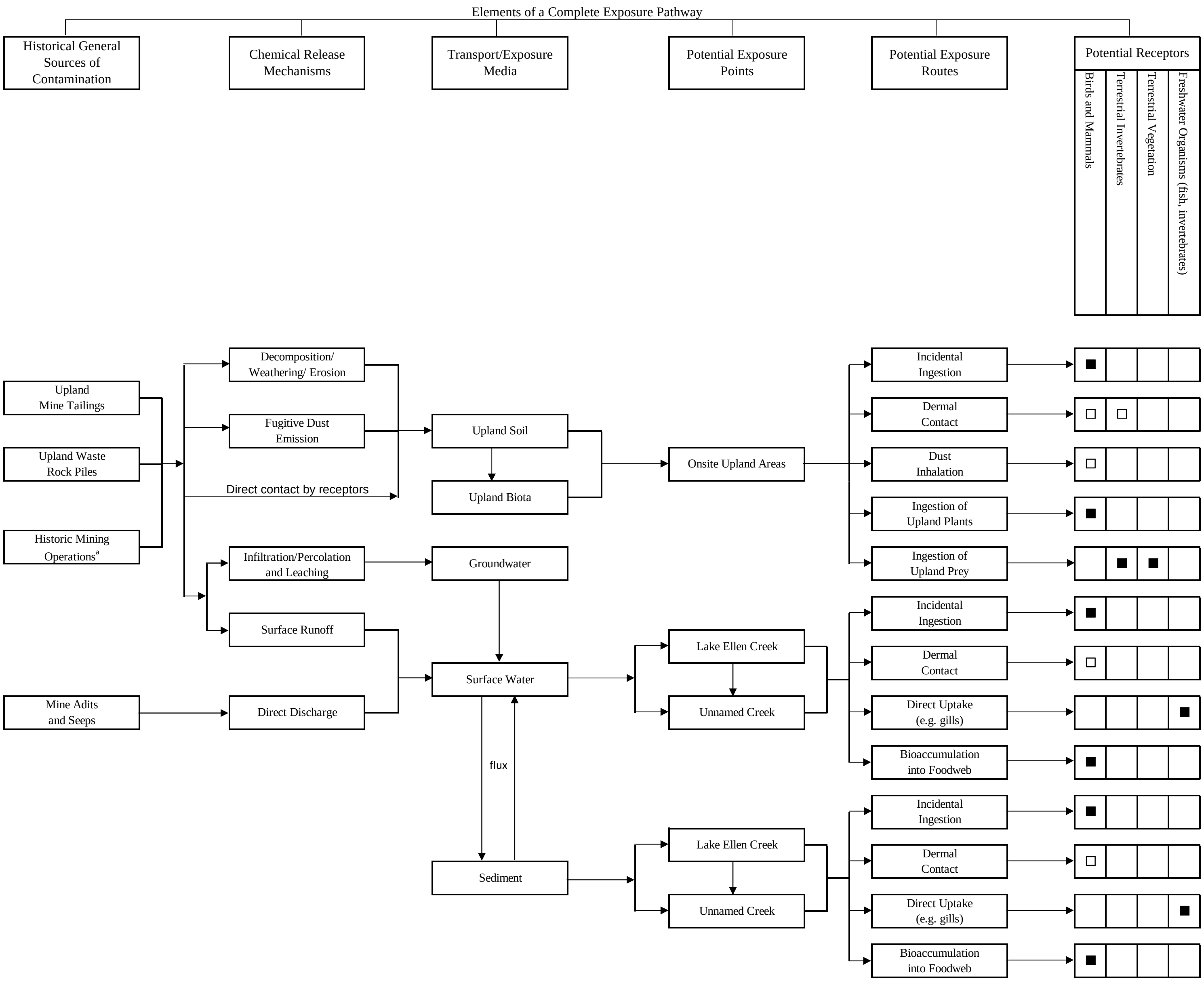
a. Includes aboveground fuel storage tanks, battery banks, and other upland sources associated with historic mining operations.

FIGURE 7

Conceptual Site Model for Potential Human Exposures for the Upland Areas

Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Risk Assessment Work Plan



Notes:
■ = Potentially complete pathway
□ = Pathway considered minor
Blank = Incomplete pathway
a. Includes aboveground fuel storage tanks, battery banks, and other upland sources associated with historic mining operations.

According to the ADNR (1998) plan, the Salt Chuck Mine falls within Land Management Subunit 11b (Karta Bay), which is designated as having high fish and wildlife habitat and harvest values. The Salt Chuck area is designated for *Intensive Community Use (Cy)* for harvest of clams, crab, oysters, waterfowl, and black bear by residents of Kasaan, Hollis, and Craig, as well as *Recreation-undeveloped (Ru)* (Figure 3; ADNR, 1998). Visitors may also collect berries, mushrooms, and sea asparagus [also known as pickleweed or glasswort (*Salicornia spp.*)] from the area. The closest of the communities, Kasaan, is located about 10 miles southeast of Salt Chuck Mine along the eastern shore of Kasaan Bay. The native Village of Kasaan utilizes Salt Chuck Bay for cultural and traditional uses, including fishing.

2.5 Water Uses

2.5.1 Surface Water

The surface water uses generally recognized for Salt Chuck Bay include fishing, shellfish harvesting, boating, water recreation, wildlife watching, aesthetic quality, salmonid fish rearing and migration, and growth, propagation and habitat for resident fish, aquatic life, and wildlife. There are no known drinking sources of surface water in the vicinity of the Salt Chuck Mine site.

2.5.2 Groundwater

Shallow groundwater occurs intermittently and seasonally just below surface soils in upland areas of the site. Groundwater is found to be very shallow in the area due to the presence of bedrock and thin soils, and migration could potentially occur along a bedrock/soil interface. When present, the depth to groundwater ranges from about 1 to 4 feet below ground surface (bgs). During low tide, a seep is visible in the intertidal flat immediately below the former mill site, and likely represents a groundwater pathway connection to intertidal zone receptors. Six groundwater monitoring wells were installed at the Salt Chuck Mill site in 2011; three in the upland tailing vicinity and three near other source areas in the former mill site.

Groundwater ingestion is not considered to be a pathway of concern for humans because there are no drinking water wells within a 15-mile target distance hydrologically downgradient of the Salt Chuck Mine site (BLM, 1998). Given the proximity of the lower portion of the site to marine and estuarine water, it is likely that groundwater in this area is not potable and would not be used for drinking water in the future. Any plausible access to potable groundwater would require drilling through the bedrock. However, groundwater in the upland area is unlikely to be developed for drinking water in the future, due to the presence of more readily available surface water sources, and low yields in bedrock aquifers.

2.6 Conceptual Exposure Model

Figures 4 and 5 show the conceptual exposure models for human exposure pathways in the intertidal and upland areas, respectively. Figures 6 and 7 show the conceptual exposure models for ecological exposure pathways in the intertidal and upland areas, respectively. The potential exposure pathways at Salt Chuck Mine and are discussed below.

2.6.1 Sources

The assessment of sources is based on known historical uses, practices, and releases at Salt Chuck Mine. The primary sources of contaminants and release mechanisms include those associated with former operations at various locations. These primary and secondary sources include the following:

- Mine tailings deposited onto upland and intertidal areas
- Historical mining operations, including aboveground fuel storage tanks, battery banks, and other upland sources of petroleum and PAHs
- Upland waste rock from mine shafts and open-pit mining

- Historical aerial releases of dust from former mill operations
- Water from mine adits and seeps
- Water and sediments in the water bodies at and near the mine site

2.6.2 Release Mechanisms and Potential Transport Media

Exposure may occur when chemicals migrate from their source to an exposure point (i.e., a location where individuals or organisms can come into contact with the chemicals) or when a receptor moves into direct contact with chemicals or contaminated media connected to the source. An exposure pathway is complete (i.e., there is exposure) if there is a means for the receptor to take in chemicals through ingestion, inhalation, or dermal absorption at a location where site-related chemicals are present. No exposure (and therefore no risk) exists unless the exposure pathway is complete. The exposure/risk linkage is an important element in the risk assessment process.

The CSM identifies the following mechanisms that could transport site-related constituents to environmental media:

- Decomposition, weathering, and erosion of contaminants from tailings and waste rock
- Leaching, percolation and infiltration of contaminants to shallow groundwater
- Surface discharge and seepage of shallow groundwater contaminated by contact with waste rock or tailings, or by flowing through underground workings
- Transport of dissolved or particulate contaminants in surface runoff to surface water and sediment in nearby water bodies
- Dust generated from wind or mechanical erosion on contaminated surface soils at the mine site. This migration pathway is considered minimal due to general wet climates and moss covering on the forest floor.

Receptors could be exposed by contaminant migration from the original release areas to potential exposure points or by direct contact with contaminated tailings, waste rock, or other media at the mine site.

Based on past site investigations, the general types of site-related contaminants identified include:

- **Metals—**at both upland and intertidal areas
- **Polynuclear aromatic hydrocarbons (PAHs)—** at both upland and intertidal areas
- **Petroleum hydrocarbons—**at both upland and intertidal areas

2.6.3 Potentially Complete Human Exposure Pathways and Receptors

On the basis of the current understanding of land and water use conditions at or near the Salt Chuck Mine site, the most plausible current or future human receptor populations include the following:

- Recreational visitors and recreational users (e.g., hikers, clam diggers)
- Customary and traditional users (e.g., hunters, anglers, clam diggers, gatherers)[1]
- Intermittent workers (e.g., foresters, prospectors, etc.)

For these potentially exposed populations, the most plausible exposure routes that will be considered for characterizing human health risks include the following:

- Incidental ingestion of, dermal contact with, and inhalation of dust from surface soil, by recreational users, customary/traditional users, and intermittent workers

[1] For the purposes of this RAWP, the term "customary and traditional user" specifically refers to local Alaska Natives who include natural food sources in their diet, either in part or in total, by hunting, fishing, and/or gathering native food for consumption. The results for this exposure scenario will also be applicable to "subsistence" users as defined in Title VIII of the Alaska National Interest Lands Conservation Act (ANILCA), including homesteaders or other non-Native people living in remote locations and exercising the traditional practice of living off the land.

- Incidental ingestion of and dermal contact with surface water and sediment by recreational users and customary/traditional users
- Consumption of shellfish and fish that have accumulated mine-related COPCs, by recreational users and customary/traditional users
- Consumption of wild game that has accumulated mine-related COPCs, by recreational users and customary/traditional users
- Consumption of upland and intertidal plants that have accumulated mine-related COPCs, by recreational users and customary/traditional users

Due to the remoteness, and high recreational value of the Salt Chuck Mine site, future residential development is unlikely; consequently, potential future residential scenarios will not be evaluated. Moreover, mining features and artifacts present throughout the site are eligible for National Register listing under the National Historic Preservation Act (NHPA) of 1966 (URS, 2010).

2.6.4 Potentially Complete Ecological Exposure Pathways and Receptors

In accordance with the CSM, plausible ecological exposure pathways that are based on the contaminant types, available habitat, and available food sources at the Salt Chuck Mine site include the following:

- Potential exposure of upland wildlife by direct contact with mine-related COPCs in soil (including incidental ingestion of soil by birds and mammals during foraging activities)
- Potential exposure of upland and intertidal wildlife by direct contact with mine-related COPCs in surface water and sediment
- Potential ingestion of mine-related COPCs via the food chain by higher trophic level upland and intertidal wildlife that may forage in the habitats at the site
- Potential exposure of aquatic and benthic resources (freshwater and marine fish, invertebrates, and amphibians) to mine-related COPCs present in surface water, sediment, forage, and prey
- Potential exposure of upland and intertidal plants to mine-related COPCs present in soil, sediment, and water

3. Data Usability and Processing

3.1 Data Usability

Analytical data obtained from the 2011, 2012, and 2013 RI at Salt Chuck Mine will be used in the HHRA and ERA. To determine whether the available analytical data are suitable for use in the risk assessment, a data usability evaluation will be performed consistent with *Risk Assessment Guidance for Superfund* (RAGS) (EPA, 1989). This determination will be based upon two lines of evaluation:

1. Identification of the adequacy of method detection limits (MDLs) for available analytical data to detect potential risks posed by the Salt Chuck Mine.
2. Evaluation of the spatial, chemical, and temporal representativeness of the available analytical data, and an assessment of whether these data are relevant to plausible exposure pathways at the Salt Chuck Mine.

MDLs for available analytical data will be compared to risk-based screening criteria (for example, EPA Regional Screening Levels, EPA, 2012a). If MDLs for the available data exceed these risk-based criteria, and are above reporting limits that are achievable using standard EPA methods, then the data may be considered inadequate for use.

In addition to evaluating MDLs, the available analytical data will also be evaluated to determine whether they are representative of potential exposures possible the Salt Chuck Mine site. The criteria for data representativeness are defined below:

- **Chemical representativeness –** Identifies whether analyses were conducted for constituents expected to be present, on the basis of an understanding of historical processes or practices and potential releases at the site.
- **Exposure representativeness –** Identifies whether environmental media were evaluated where receptor exposure is most feasible (for example, surface soil sampling locations, dissolved versus total metals, etc).
- **Spatial representativeness –** Identifies whether samples were collected with a sufficient density and areal coverage that the detected constituent concentrations represent a geographically-integrated exposure for the receptors of concern.
- **Temporal representativeness –** Identifies whether samples were collected within a time frame such that detected constituent concentrations indicate current site conditions.

These criteria will be considered collectively during data evaluation to judge whether site data are useable for risk assessment purposes, and to identify any associated uncertainties to be reported in the uncertainties section of the risk assessment report.

3.2 Data Processing Procedures

Prior to use in the risk assessment, laboratory analytical data will be processed so that only reliable data are included. The data processing will be consistent with RAGS (EPA, 1989) and consist of the following checks:

- Estimated values flagged with a “J” qualifier will be treated as qualified detected concentrations.
- Data for detected constituents that are also detected in method blanks will not be used in the risk assessment.
- For duplicate samples, the following procedure will be applied: (a) if there are two detections, the maximum value will be used; (b) if there is one detection and one nondetection, the detected value will be used; (c) if there are two nondetections, the lowest detection limit will be used.
- Data qualified with an “R” (rejected) will not be used in the risk assessment and not included in the total count of samples analyzed for a constituent.

4. Human Health Risk Assessment Methodology

The baseline HHRA will present an analysis of the potential for adverse human health effects potentially associated with chemical releases at the Salt Chuck Mine. U.S. EPA and Alaska DEC guidance for preparing HHRAs will be consulted in the development of the human health risk evaluation.

4.1 Human Health Risk Assessment Guidance

The procedures described in this Work Plan are consistent with those described in following federal and state guidance documents:

- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual, Part A (Interim Final)* (EPA, 1989)
- *Risk Assessment Guidance for Superfund, Volume 1: Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure Factors* (EPA, 1991a)
- *Soil Screening Guidance: Users Guide, Second Edition* (EPA, 1996a)
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment, Final)* (EPA, 2004)
- *Guidelines for Carcinogen Risk Assessment.* (EPA, 2005)
- *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)* (EPA, 2009a)
- *ProUCL Version 4.1.00 Technical Guide* (EPA, 2010a)
- *Exposure Factors Handbook* (EPA, 2011a)
- *Risk Assessment Procedures Manual* (Draft) (ADEC, 2011)

4.2 Identification of Chemicals of Potential Concern for Human Health

COPCs are those constituents that are carried through the human health risk quantification process. During the course of the HHRA, the COPCs will be evaluated to identify and prioritize which constituents, if any, are estimated to pose unacceptable risks and therefore may need to be addressed during a Feasibility Study.

Historical investigations at the Salt Chuck Mine site have focused the general constituent types that have been released to site media of concern. These previous site investigations are documented in the *Final Report, Removal Preliminary Assessment, Salt Chuck Mine, Ketchikan Ranger District, Tongass National Forest, Region 10 - Alaska* (BLM 1998), *Draft Report Engineering Evaluation/Cost Analysis, Salt Chuck Mine Tongass National Forest, Alaska (*Draft EE/CA) (URS 2007), *Final Completion Report Non-Time Critical Removal Action Salt Chuck Mine Mill Prince of Wales Island, Alaska* (North Wind, 2012), *Preliminary Findings for Pre-RI 2011 Field Sampling Activities Technical Memorandum* (CH2M HILL, 2012b), and the *Salt Chuck Mine – Preliminary Findings for Remedial Investigation 2012 Field Sampling Activities* (CH2M HILL, 2013).

Based on these past site investigations, the general types of site-related contaminants identified include:

- **Metals–**at both upland and intertidal areas
- **PAHs–**at both upland and intertidal areas
- **Petroleum hydrocarbons–**at both upland and intertidal areas

Since the general area was historically mined because the soil is rich in minerals and metals, the inorganic COPCs that will be identified for site media of concern will include constituents that also occur naturally. In areas of past mining activity the availability of and potential for these constituents to adversely affect human health and the environment may have been increased for several reasons, including changes in the topography and hydrology of the mine area that can result in increased erosion, surface water runoff, and sediment transport to downstream areas as well as geochemical changes in the metals or other parameters (e.g., pH). It is possible that some metals occur at levels above risk-based screening criteria in site and/or background areas. Consistent with EPA policy (EPA, 2002a), no COPC will be eliminated based on comparison to background concentrations. Instead, potential risks and hazards from both site and background (or reference) areas will be characterized, as described in Section 4.5.4.

4.2.1 COPC Selection Process

With consideration of the data usability conclusions (per Section 3) and in accordance with EPA guidance, the following factors will be considered in identifying COPCs:

- Identification of detected chemicals
- Screening values based on toxicological characteristics of each chemical
- Identification of essential nutrients
- Availability of toxicity factors

COPCs will be identified separately for soil, sediment, surface water, and biota. Evaluation of the risk assessment data using these criteria is discussed in the following sections.

4.2.1.1 Identification of Detected Chemicals

All chemicals detected at least once in site media (including estimated detections) will be included as potential COPCs. If a detected constituent is found to be a contributor to risk or hazard, but has a very low detection frequency, the associated uncertainties will be addressed in the uncertainty section of the HHRA. As described in the work planning documents for the RI (CH2M HILL, 2012a), the limits of detection used for the investigations were targeted to meet conservative risk-based analytical goals, so that they would be low enough to determine the presence or absence of unacceptable risk.

4.2.1.2 Comparison with Risk-Based Screening Values

Maximum concentrations found in each environmental medium (soil, sediment, water, and biota) will be compared to conservative risk-based screening concentrations to identify chemicals for inclusion into the risk assessment. Screening levels will include EPA Regional Screening Levels (RSLs) for the most conservative residential use scenario (EPA 2012a), equivalent to a cancer risk of 10^{-6} for carcinogens, and adjusted to a hazard quotient (HQ) equal to 0.1 for noncarcinogens.

4.2.1.3 Identification of Essential Nutrients

Essential nutrients are those chemicals considered essential for human nutrition. Recommended daily allowances are developed for essential nutrients to estimate safe and adequate daily dietary intakes (National Academy of Sciences, 2006). Because calcium, magnesium, potassium, and sodium are considered to be naturally occurring essential nutrients and are generally recognized as being of low toxicity, they will be considered for exclusion as COPCs. Other essential nutrients such as chromium, copper, iron, and zinc will be included as COPCs, because these can be toxic if levels are very high.

4.2.1.4 Availability of Toxicity Factors

If a human health toxicity value for a constituent is not available from a reliable source (as described in Section 4.4), that constituent cannot be included as a COPC in the risk quantification process. However in some cases where adequate toxicity data are unavailable, structurally similar surrogates can be used for these constituents. For example, the toxicity factors for acenaphthene may be used for acenaphthylene, for which none are available. Those constituents without reliable toxicity factors or a suitable surrogate will be discussed in the uncertainty section of the HHRA.

4.3 Human Exposure Assessment

The exposure assessment step of the HHRA for Salt Chuck mine will include the following activities:

- Calculation of exposure point concentrations (EPCs)
- Development of human exposure assumptions for potentially complete exposure pathways
- Calculation of chemical intake for COPCs

These activities are discussed in the following subsections.

4.3.1 Estimating Exposure Point Concentrations

EPCs are estimated constituent concentrations with which a receptor may come into contact, and are specific to each exposure medium. The EPCs for exposure pathways associated with Salt Chuck Mine will be estimated, where appropriate, by aggregating concentration data from media samples collected over a relevant exposure area. The EPCs for aggregate risk estimation will be calculated by using the best statistical estimate of an upper bound on the average exposure concentrations, in accordance with EPA guidance for statistical analysis of monitoring data (EPA, 1989, 1992a, 2002b). EPA considers the 95 percent upper confidence limit (UCL) on the mean concentration as a conservative upper bound estimate that is not likely to underestimate the mean concentration. EPCs will be calculated for each analyte using EPA's statistical program ProUCL, Version 4.1.01 (EPA, 2011b). This procedure identifies the statistical distribution type (that is, normal, lognormal, or non-parametric) for each constituent within the defined exposure area (the area of interest) and computes the corresponding 95 percent UCL for the identified distribution type. Generally, at least 8 to 10 samples are needed to compute a meaningful UCL. The maximum detected concentration will be used in place of the 95 percent UCL when the calculated 95 percent UCL is greater than the maximum detected value. However, using maximum detected values for EPCs may contribute to overestimation of risk. If a maximum value is used and found to contribute to risk or hazard, the associated uncertainties will be addressed in the uncertainty section of the HHRA. Summary statistics for all site media investigated, including the UCL recommended by ProUCL for each COPC, will be tabulated in the HHRA report. The ProUCL output summaries will also be provided as an attachment.

The exposure areas over which investigation data will be aggregated for computation of UCLs will be determined once the 2013 RI investigation activities are complete. Due to the geographic scale of the RI, the spatial representativeness, chemical concentration trends, and numbers of samples will all be considered to decide exposure areas for the risk assessment. For the intertidal area, the mud flats adjacent to the former mill site will likely represent a single exposure area where recreational or customary/traditional users could be exposed to sediment, water, or biota. Other areas and media with much lower concentrations of mine-related constituents may be addressed using screening approaches, rather than by computing areally-averaged results for exposure areas.

4.3.2 Human Exposure Assumptions

The estimation of exposure requires numerous assumptions to describe potential exposure situations. Upper-bound exposure assumptions are used to estimate "reasonable maximum exposure" (RME) conditions to provide a bounding estimate on exposure. The exposure assumptions to be used for the HHRA will be specific to the identified exposure scenarios at Salt Chuck Mine. The scenarios to be evaluated were selected based on the conceptual exposure models for the intertidal and upland areas (Figures 4 and 5) and are consistent with the reasonably anticipated future land uses. Based on the known and anticipated activities at the Salt Chuck Mine site, the following receptors were selected to represent current or potential future use of the site:

- Recreational users (e.g., hikers, clam diggers) – adult and child
- Customary/traditional users (e.g., hunters, anglers, clam diggers, gatherers) – adult and child
- Intermittent workers (e.g., foresters, prospectors, etc.) – adult only

4.3.2.1 Recreational Visitor or Customary/Traditional Users

Recreational visitors and customary/traditional users are assumed to visit the site for a portion of the year, for example during the time when berries are ripe or when hunting and angling seasons apply. It is assumed that recreational or customary/traditional users would potentially access the site on foot or by boat. It is also assumed that the recreational or customary/traditional users would consume local plants, hunt game, catch fish, or harvest shellfish from the site. However, only a percentage of total native food consumed by the recreational user or customary/traditional user would be gathered specifically from the site[2]. The most plausible exposure routes for recreational or customary/traditional users would include:

- Incidental ingestion of, dermal contact with, and inhalation of dust from surface soil
- Incidental ingestion of and dermal contact with surface water and sediment
- Consumption of shellfish and fish
- Consumption of wild game
- Consumption of upland and intertidal plants

4.3.2.2 Intermittent or Seasonal Workers

The Salt Chuck Mine site includes lands managed by the U.S. Forest Service. Also, there are currently active mining claims held at and near the Salt Chuck Mine site. For the purposes of the HHRA and given these identified land uses, it is assumed that intermittent or seasonal forestry and/or mine workers would occasionally work at the site and live in nearby Thorne Bay (the closest year-around population) or farther communities. It is also assumed these workers could directly contact upland surface soil, surface water, and sediment. The most plausible exposure routes for intermittent workers would include:

- Incidental ingestion of, dermal contact with, and inhalation of dust from upland surface soil
- Incidental ingestion of and dermal contact with upland surface water and sediment

The exposure parameters used for generating RME risk and hazard estimates are listed in Table 6. Many of the exposure assumptions for ingestion, dermal contact, and inhalation are default values provided by EPA guidance documents (listed in Section 4.1). Some of the exposure assumptions (e.g., exposure frequencies and durations for all receptors) will be based on site-specific information or best judgment.

4.3.3 Calculation of Chemical Intake

Exposure that is normalized over time and body weight is termed intake (expressed as milligrams of chemical per kilogram body weight per day [mg/kg-day]). This section describes the equations that will be used to calculate exposures to contaminants in surface soil, sediment, surface water, ambient air, and edible biota. Consistent with EPA guidance, exposure estimates will be calculated for RME conditions.

4.3.3.1 Incidental Ingestion of Soil or Sediment

The following equation will be used to estimate the intake associated with the incidental ingestion of contaminants in soil or sediment for the recreational user (soil and sediment), customary/traditional user (soil and sediment), and intermittent worker (soil), exposure scenarios:

$$Intake = \frac{C_s \times IR_s \times 10^{-6} kg/mg \times EF \times ED}{BW \times AT}$$

where:

C_S	=	Constituent concentration in soil or sediment (mg/kg)
IR_S	=	Soil or sediment ingestion rate (mg/day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

The exposure assumptions to be used for estimating chemical intake from the ingestion of contaminants in soil or sediment are provided in Table 6.

[2] Exposure estimates may initially assume 100 percent of food items come from the site, but could be adjusted based on consideration of local community questionnaire results.

4.3.3.2 Incidental Dermal Contact with Soil or Sediment

Chemical intake from dermal contact with soil or sediment for the recreational user (soil and sediment), customary/traditional user (soil and sediment), and intermittent worker (soil) exposure scenarios will be estimated using the following equation:

$$Intake = \frac{C_S \times SA \times ABS \times AF \times EF \times ED \times 10^{-6}\, kg/mg}{BW \times AT}$$

where:

C_S	=	Constituent concentration in soil or sediment (mg/kg)
SA	=	Exposed skin surface area (cm^2)
ABS	=	Fraction of constituent absorbed from soil/sediment to skin (unitless)
AF	=	Skin adherence factor (mg/cm^2)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

The exposure assumptions to be used for estimating exposure from dermal contact with soil or sediment are provided in Table 6. Dermal absorption fractions (ABS) values will be derived from the EPA's *Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004).

4.3.3.3 Inhalation of Fugitive Dust Originating from Surface Soil

In accordance with EPA (2009a), the exposure concentration from inhalation of fugitive dust emissions originating from surface soil for the recreational user, customary/traditional user, and intermittent worker exposure scenarios will be estimated using the following equation:

$$EC_a = \frac{C_s \times \left(\frac{1}{PEF} + \frac{1}{VF}\right) \times ET \times EF \times ED}{AT}$$

where:

EC_a	=	Exposure concentration in ambient air (mg/m^3)
C_s	=	Constituent concentration in soil or sediment (mg/kg)
ET	=	Exposure time (unitless fraction of day)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
PEF	=	Particulate emission factor (m^3/kg)
VF	=	Volatilization factor (m^3/kg)
AT	=	Averaging time (days)

The particulate emission factor (PEF) to be used is the default value recommended by EPA Regional Screening Levels (RSLs) (EPA, 2012a). The exposure assumptions to be used to estimate exposure from inhalation of dust from surface soil are provided in Table 6.

4.3.3.4 Incidental Ingestion of Surface Water

The following equation will be used to estimate the intake associated with the incidental ingestion of constituents in surface water for the recreational user, customary/traditional user, and intermittent worker exposure scenarios:

$$Intake = \frac{C_w \times IR_w \times EF \times ED}{BW \times AT}$$

where:

C_W = Constituent concentration in surface water (mg/L)
IR_W = Surface water ingestion rate (L/day)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

The exposure assumptions to be used for estimating chemical intake from the incidental ingestion of constituents in surface water are provided in Table 6.

4.3.3.5 Incidental Dermal Contact with Surface Water

Chemical intake from dermal contact with surface water for the recreational user, customary/traditional user, and intermittent worker exposure scenarios will be estimated using the following equation:

$$Intake = \frac{DA_{event} \times SA \times EF \times ED}{BW \times AT}$$

where:

DA_{event} = Calculated in accordance with EPA (2004) (mg/cm^2-event)
SA = Exposed skin surface area (cm^2)
EF = Exposure frequency (days/year)
ED = Exposure duration (years)
BW = Body weight (kg)
AT = Averaging time (days)

DA_{event} will be calculated for inorganic chemicals detected in surface water as follows:

$$DA_{event} = K_p \times C_{sw} \times t_{event}$$

where:

DA_{event} = Absorbed dose per event (mg/cm^2-event)
K_p = Dermal permeability coefficient (cm/hour)
C_{sw} = Constituent concentration in surface water (mg/cm^3)
t_{event} = Event duration (hr/event)

The exposure assumptions to be used to estimate exposure from dermal contact with surface water are provided in Table 6. Chemical-specific dermal permeability coefficients (Kp) will be obtained from the Oak Ridge National Laboratory (ORNL) Risk Assessment Information System (ORNL 2011), calculated using EPA's Dermwin™ tool that is part of its Estimation Program Interface (EPI) Suite program.

4.3.3.6 Consumption of Wild Plants

The following age-weighted equation will be used to calculate the intake associated with the ingestion of COPCs in native plants for recreational user and customary/traditional user exposure scenarios:

$$Intake = \frac{C_p \times IFP_{adj} \times FI \times EF \times 10^{-6}\, kg/mg}{AT}$$

where:

$$IFP_{adj} = \frac{ED_c \times IRP_c}{BW_c} + \frac{ED_a \times IRP_a}{BW_a}$$

and where:

C_p	=	Constituent concentration in wild plants (mg/kg)
IFP_{adj}	=	Age-adjusted plant ingestion factor [(mg-year)/(kg-day)]
IRP_a	=	Adult wild plant ingestion rate (mg/day)
IRP_c	=	Child wild plant ingestion rate (mg/day)
BW_a	=	Adult body weight (kg)
BW_c	=	Child body weight (kg)
FI	=	Fraction ingested from contaminated source (unitless)
EF	=	Exposure frequency (days/year)
ED_a	=	Adult exposure duration (years)
ED_c	=	Child exposure duration (years)
AT	=	Averaging time (days)

4.3.3.7 Consumption of Wild Game

Calculation of intake from consumption of wild game will be conducted in two steps. First, the COPC concentration in meat tissue will be estimated from measured concentrations in site soils. Second, the COPC intake from daily consumption of these foods will be calculated. The equations for these two steps are as follows:

The equation for estimating the chemical concentration in animal tissue is adapted from equations 6-2 and 6-25 of EPA guidance in *Methodology for Assessing Health Risks Associated with Multiple Pathways of Exposure to Combustor Emissions* (EPA, 1998a) as follows:

$$C_T = \left(\left(C_p \times P_p \times F\right) + \left(C_s \times P_s\right)\right) \times BAF_L \times L_T$$

where:

C_T	=	Constituent concentration in wild game tissue (mg/kg)
C_p	=	Constituent concentration in wild plant (mg/kg)
P_p	=	Proportion of animal diet as wild plants (unitless)
F	=	Fraction of game animal diet originating from site[3] (unitless)
C_s	=	Constituent concentration in soil (mg/kg)
P_s	=	Proportion of diet as incidentally ingested soil (unitless)
BAF_L	=	Diet-to-animal tissue lipid bioaccumulation factor (unitless)
L_T	=	Fraction of game animal tissue as lipid (unitless)

Chemical intake from the consumption of wild game harvested from the site, for the recreational user and customary/traditional user exposure scenarios, will be estimated using the following equation:

$$Intake = \frac{C_t \times IR_t \times 10^{-3} \times FI \times EF \times ED}{BW \times AT}$$

where:

C_T	=	Constituent concentration in wild game tissue (mg/kg, wet-weight basis)
IR_t	=	Wild game ingestion rate (g/day, wet-weight basis)
FI	=	Fraction ingested from contaminated source (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

[3] Accounts for area use by harvested wildlife

4.3.3.8 Consumption of Shellfish

Chemical intake from the consumption of shellfish harvested from the site, for the recreational user and customary/traditional user exposure scenarios, will be estimated using the following equation:

$$Intake = \frac{C_t \times IR_t \times 10^{-3} \times FI \times EF \times ED}{BW \times AT}$$

where:

C_t	=	Constituent concentration in shellfish tissue (mg/kg, wet-weight basis)
IR_t	=	Shellfish tissue ingestion rate (g/day, wet-weight basis)
FI	=	Fraction ingested from contaminated source (unitless)
EF	=	Exposure frequency (days/year)
ED	=	Exposure duration (years)
BW	=	Body weight (kg)
AT	=	Averaging time (days)

The constituent concentrations in shellfish tissues will come from direct measurements during the 2011, 2012, and 2013 RI. Based on the types of constituents found at the site, and since most site contamination is associated with intertidal sediment, it is anticipated that concentrations found in shellfish will provide the most conservative estimates of potential consumption exposure, when compared to potential consumption of locally-harvested fish. The exposure assumptions to be used to estimate exposure from biota consumption are provided in Table 6. There are no default agency-derived ingestion rates for wild food. Wild food intake rates for all receptors (recreational and customary/traditional users) will be developed prior to development of the HHRA. Available data sources on customary/traditional use and consumption rates for the communities of Kasaan, Hollis, and Craig will be considered, including the Alaska Department of Fish and Game (ADFG) Division of Subsistence, Community Subsistence Information System (ADFG, 2013a) and the Final Report on the Alaska Traditional Diet Survey (ANHB, 2004).

4.3.3.9 Calculation of Intake for Mutagenic COPCs

Early-in-life susceptibility to carcinogens has been recognized by the scientific community as a public health concern. In its revised cancer assessment guidelines, EPA concluded that existing risk assessment approaches did not adequately address the possibility that exposures to a chemical in early life can result in higher lifetime cancer risks than a comparable duration adult exposure (EPA, 2005). In order to address this potential for increased risk, EPA recommends use of a potency adjustment to account for early-in-life exposures. When no chemical-specific data are available to directly assess cancer susceptibility from early-life exposure, the following default Age Dependent Adjustment Factors (ADAFs) are recommended for use when evaluating a carcinogen known to cause cancer through a mutagenic mode of action:

- 10-fold adjustment for exposures during the first two years of life;
- Three-fold adjustment for exposures from ages 2 to <16; and
- No adjustment for exposures after turning 16 years of age.

Of the contaminants evaluated during the 2011 and 2012 RI, EPA considers that there is sufficient weight of evidence to conclude that the carcinogenic PAHs cause cancer through a mutagenic mode of action. Consideration of early-life stage exposure for these PAHs would be limited to the recreational and customary/traditional user exposure scenarios.

4.4 Human Health Toxicity Assessment

The toxicity assessment component of the HHRA identifies the types of toxic effects a chemical can exert. Chemicals are divided into two broad groups on the basis of their effects on human health: noncarcinogens and carcinogens. This classification has been selected because health risks are calculated quite differently for carcinogenic and noncarcinogenic effects, and separate toxicity values are developed for them.

Carcinogens are those chemicals suspected of causing cancer following exposure; noncarcinogenic effects cover a wide variety of systemic effects, such as liver toxicity or developmental effects. Some chemicals (such as arsenic) are capable of eliciting both carcinogenic and noncarcinogenic responses; therefore, these carcinogens will be also evaluated for systemic (noncarcinogenic) effects.

4.4.1 Reference Doses for Noncancer Effects

The toxicity value describing the dose-response relationship for noncancer effects is the reference dose value (RfD), or in the case of inhalation, the reference concentration, or RfC. For noncarcinogenic effects, the body's protective mechanisms must be overcome before an adverse effect is manifested. If exposure is high enough and these protective mechanisms (or thresholds) are exceeded, adverse health effects can occur. EPA attempts to identify the upper bound of this tolerance range in the development of noncancer toxicity values. EPA uses the apparent toxic threshold value, in conjunction with uncertainty factors based on the strength of the toxicological evidence, to derive an RfD or RfC. EPA defines an RfD (also applies to RfC) as follows (EPA, 1989):

> *"In general, the RfD is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. The RfD is generally expressed in units of mg/kg of body weight each day (mg/kg-day)."*

The HHRA will use available chronic RfDs and RfCs for the oral and inhalation exposure routes, respectively. Because EPA has not derived toxicity values specific to skin contact, dermal RfDs will be derived in accordance with the EPA *Supplemental Guidance for Dermal Risk Assessment* (2004). The RfD that reflects the absorbed dose will be calculated by using the following equation:

$$RfD_{ABS} = RfD_o \times ABS_{GI}$$

where:

RfD_{ABS} = Absorbed reference dose
RfD_o = Oral reference dose
ABS_{GI} = Gastrointestinal (GI) absorption efficiency

The EPA recommends adjusting oral toxicity values only when evidence suggests that GI absorption is less than 50 percent. GI absorption efficiencies will be obtained from the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004).

4.4.2 Slope Factors for Cancer Effects

The dose-response relationship for cancer effects is expressed as a cancer slope factor (SFs) that converts estimated intake directly to excess lifetime cancer risk. SFs are presented in units of risk per level of exposure (or intake). The data used for estimating the dose-response relationship are taken from lifetime animal studies or human occupational or epidemiological studies in which excess cancer risk has been associated with exposure to the chemical. However, because risk at low intake levels cannot be directly measured in animal or human epidemiological studies, a number of mathematical models and procedures have been developed to extrapolate from the high doses used in the studies to the low doses typically associated with environmental exposures. The model choice leads to uncertainty. EPA generally assumes linearity at low doses and uses the linearized multistage procedure when uncertainty exists about the mechanism of action of a carcinogen and when information suggesting nonlinearity is absent.

It is assumed, therefore, that if a cancer response occurs at the dose levels used in the studies, there is some probability that a response will occur at all lower exposure levels (that is, a dose-response relationship with no threshold is assumed). Moreover, the dose-response slope chosen is usually the UCL on the dose-response curve observed in the laboratory studies. As a result, uncertainty and conservatism are built into the EPA risk extrapolation approach. EPA has stated that cancer risks estimated by this method produce estimates that "provide a rough but plausible upper limit of risk." In other words, it is not likely that the true risk would be much more than the estimated risk, but "the true value of the risk is unknown and may be as low as zero" (EPA, 1986a).

Because EPA has not derived toxicity values specific to skin contact, dermal SFs will be derived in accordance with the EPA *Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004). The SF that reflects the absorbed dose will be calculated by using the following equation:

$$SF_{ABS} = \frac{SF_o}{ABS_{GI}}$$

where:

SF_{ABS} = Absorbed slope factor
SF_o = Oral slope factor
ABS_{GI} = GI absorption efficiency

The EPA recommends adjusting oral toxicity values only when evidence suggests that GI absorption is less than 50 percent. GI absorption efficiencies will be obtained from the *Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual Part E, Supplemental Guidance for Dermal Risk Assessment* (EPA, 2004).

For the inhalation route, the HHRA will use the inhalation unit risk (IUR) to estimate risk in accordance with *Risk Assessment Guidance for Superfund–Volume I: Human Health Evaluation Manual (Part F, Supplemental Guidance for Inhalation Risk Assessment)* (EPA, 2009a). EPA defines an IUR as "the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m^3 in air" (EPA, 2008).

For cancer effects, EPA developed a carcinogen classification system (EPA, 1986a) that used a weight-of-evidence approach to classify the likelihood that a chemical is a human carcinogen. This classification scheme has been superseded in the more recent *Guidelines for Carcinogen Risk Assessment* (EPA, 2005), where a narrative approach, rather than the alphanumeric categories, is used to characterize carcinogenicity. Five standard weight-of-evidence descriptors are used: *Carcinogenic to Humans, Likely to Be Carcinogenic to Humans, Suggestive Evidence of Carcinogenic Potential, Inadequate Information to Assess Carcinogenic Potential, and Not Likely to Be Carcinogenic to Humans.*

4.4.3 Sources of Toxicity Values

In accordance with EPA guidance (EPA, 2003a), the toxicity values (cancer slope factors and reference doses) used in the HHRA will be obtained from the following sources in order of preference:

- The Integrated Risk Information System (IRIS) database available through the EPA Environmental Criteria and Assessments Office in Cincinnati, Ohio (EPA, 2012a). IRIS, prepared and maintained by EPA, is an electronic database containing health risk and EPA regulatory information on specific chemicals.
- EPA Provisional Peer Reviewed Toxicity Values (PPRTVs), provided by the Office of Research and Development, National Center for Environmental Assessment, Superfund Health Risk Technical Support Center, which develops these values on a chemical-specific basis when requested under the EPA Superfund program. PPRTVs will be obtained from EPA regional screening level (RSL) tables (EPA, 2012b).
- Other sources of information, with a preference for sources that (1) provide toxicity information based on similar methods and procedures as those used for IRIS and PPRTV values, and (2) contain values that are peer-reviewed, available to the public, and transparent with respect to the methods and processes used to develop the values. Examples of recommended sources include, but are not limited to, the California Environmental Protection Agency (CAEPA), available at http://www.oehha.ca.gov/tcdb/, and the Agency for Toxic Substances and Disease Registry (ATSDR) Minimal Risk Levels (MRLs), which represent estimates of the daily human exposure to a hazardous substance that is likely to be without appreciable risk of adverse non-cancer health effects over a specified duration of exposure.

The toxicity values to be used in the HHRA are listed in Table 7**.** The most current version of the EPA RSL tables will be used for the risk assessment.

4.4.4 Use of Toxicity Equivalency Factors for PAHs

If carcinogenic PAHs (cPAHs) are identified as COPCs at the site, they will be assessed using a toxicity equivalency factor (TEF) approach consistent with the EPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA, 1993a). The TEFs to be used to assess the potency of individual PAHs relative to benzo(a)pyrene are as follows:

- Carcinogenic PAH Compound: TEF
- Benzo(a)pyrene: 1
- Benzo(a)anthracene: 0.1
- Benzo(b)fluoranthene: 0.1
- Benzo(k)fluoranthene: 0.01
- Chrysene: 0.001
- Dibenz(a,h)anthracene: 1
- Indeno(1,2,3-cd)pyrene: 0.1

4.5 Human Health Risk Characterization

This section summarizes the methods to be used to develop the human health risk estimates for Salt Chuck Mine. In the risk characterization step, quantification of risk is accomplished by combining the results of the exposure assessment (estimated chemical intakes and exposure concentrations) with the results of the dose-response assessment (toxicity values identified in the toxicity assessment) to provide numerical estimates of potential human health effects. The approach differs for potential cancer and noncancer effects, as described in the following sections.

Although the HHRA will produce numerical estimates of risk, it should be recognized that these numbers are not predictive of actual health outcomes. Rather, they will provide a frame of reference for risk management decision-making, and interpretation of the risk estimates provided should consider the nature and weight of evidence supporting these estimates, as well as the magnitude of uncertainty surrounding them.

4.5.1 Noncancer Hazard Estimation

For noncancer effects, the likelihood that a receptor will develop an adverse effect will be estimated by comparing the predicted level of exposure for a particular chemical with the highest level of exposure that is considered protective (that is, its RfD). The ratio of the intake divided by RfD is termed the hazard quotient (HQ):

$$HQ = \frac{Intake}{RfD}$$

where:

HQ = Noncancer hazard quotient from route of exposure
Intake = Chronic daily intake averaged over the exposure duration (mg/kg-day)
RfD = Noncancer reference dose (mg/kg-day)

For noncancer effects by inhalation exposure, the following equation will be used:

$$HQ_{inh} = \frac{EC}{RfC}$$

where:

HQ_{inh} = Noncancer hazard quotient from inhalation
EC = Exposure concentration in air (mg/m^3)
RfC = Noncancer reference concentration (mg/m^3)

When the HQ for a chemical exceeds 1 (i.e., exposure exceeds the RfD or RfC), there is a concern for potential noncancer health effects. To assess the potential for noncancer effects posed by exposure to multiple chemicals, a hazard index (HI) approach will be used in accordance with EPA guidance (1989). This approach assumes that the noncancer hazard associated with exposure to more than one chemical is additive; therefore, synergistic or antagonistic interactions between chemicals are not accounted for. The HI may exceed 1 even if all the individual HQs are less than 1. In this case, the chemicals may be segregated by similar mechanisms of toxicity and toxicological effects. Separate HIs may then be derived based on mechanism and effect. The HI will be calculated as follows:

$$HI = \frac{Intake_1}{RfD_1} + \frac{Intake_2}{RfD_2} + \ldots \frac{Intake_i}{RfD_i}$$

where:

HI = Hazard index
$Intake_i$ = Daily intake of the i^{th} chemical (mg/kg-day)
RfD_i = Reference dose of the i^{th} chemical (mg/kg-day)

Both intake and RfD (or in the case of inhalation, the exposure concentration and RfC) are expressed in the same units (mg/kg-day or mg/m^3) and represent the same exposure period (i.e., chronic exposure).

4.5.2 Cancer Risk Estimation

The potential for cancer effects will be evaluated by estimating excess lifetime cancer risk (ELCR). This risk is the incremental increase in the probability of developing cancer during one's lifetime in addition to the background probability of developing cancer (i.e., if no exposure to mine-related chemicals occurs). For example, an ELCR of 2×10^{-6} means that for every 1 million people exposed to the carcinogen throughout their lifetimes, the average incidence of cancer may increase by two cases of cancer. In the United States, the background probability of developing cancer for men is a little less than one in two and for women is a little more than one in three (American Cancer Society 2008). As previously noted, cancer slope factors developed by EPA represent upper-bound estimates; therefore, any cancer risks generated in the HHRA should be regarded as an upper bound on the potential cancer risks. The actual cancer risk may be less than that predicted, and may be zero (EPA, 1989).

ELCR will be estimated by using the following equation:

$$Risk = Intake \times SF$$

where:

Risk = Excess lifetime cancer risk (unitless probability)
Intake = Chronic daily intake averaged over a lifetime (mg/kg-day)
SF = Cancer slope factor $(mg/kg\text{-}day)^{-1}$

Inhalation risk will be calculated by multiplying the exposure concentration by the inhalation unit risk (IUR). The IUR is expressed in different units than the cancer slope factor (above), and a conversion factor is necessary to normalize units between the IUR and exposure concentration values. Inhalation risk is estimated by using the following formula:

$$Risk_{inh} = EC_a \times IUR \times CF$$

where:

$Risk_{inh}$ = Excess lifetime cancer risk from inhalation (unitless probability)
EC_a = Exposure concentration in air (mg/m^3)
IUR = Inhalation unit risk $(\mu g/m^3)^{-1}$
CF = Conversion factor (µg/mg)

Although synergistic or antagonistic interactions might occur between cancer-causing chemicals and other chemicals, information is generally lacking in the toxicological literature to predict quantitatively the effects of these potential interactions. Therefore, cancer risks are treated as additive within an exposure route in this assessment. This approach is consistent with the EPA guidelines for the health risk assessment of chemical mixtures (EPA, 1986b). For estimating the cancer risks from exposure to multiple carcinogens from a single exposure route, the following equation is used:

$$Risk_T = \sum_1^N Risk_i$$

where:

$Risk_T$	=	Total cancer risk from route of exposure
$Risk_i$	=	Cancer risk for the i^{th} chemical
N	=	Number of chemicals

The human health risk will be calculated using a two-step process: (1) calculate risk (either ELCR or HQ) from the EPCs for each contaminant, and (2) sum the risk estimates from all contaminants to estimate the total ELCR or HI. The total ELCR and HI estimates will be expressed in one significant figure, in accordance with EPA and ADEC guidance.

4.5.3 Risk Estimation Method for Lead

Potential adverse health effects from lead will be evaluated using different methods than those conventionally used for other chemicals. This is because for lead most human health effects data are based on blood lead concentrations rather than on the external dose. The adverse health outcomes, which include neurotoxic and developmental effects, may occur at exposures so low that they may be considered to have no threshold. EPA views it as inappropriate to develop noncarcinogenic “safe” exposure levels (RfDs) for lead. Instead, a biokinetic model is used that relates exposure to measured lead concentrations in the environmental media with an estimated blood-lead level. For the HHRA, potential adverse health effects from lead will be evaluated by comparing the EPC for lead in soil and sediment to the residential and industrial RSLs of 400 mg/kg and 800 mg/kg, respectively (EPA, 2012b).

Under federal guidance, the soil RSL for residential land use was derived by EPA using the Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model (EPA, 2010b). The IEUBK model is designed to predict probable blood-lead concentrations for children between 6 months and 7 years of age who have been exposed to lead through various sources (for example, air, water, soil, diet, and *in utero* contributions from the mother). A predicted blood-lead level of 10 µg/dL in greater than 5 percent of the potentially exposed population is considered by EPA to be a level of concern that triggers intervention to reduce exposure. Blood lead levels above this are therefore considered to pose unacceptable risk. The soil RSL for worker scenarios was derived by EPA based on the Adult Lead Model (ALM) version date June 21, 2009 (EPA, 2003b). The ALM develops a risk-based soil concentration that is protective of fetuses carried by women who may be exposed to lead. Potential risk from lead in surface water will be conservatively evaluated by comparing the EPC in water to the drinking water action level of 0.015 milligrams per liter [mg/L]).

4.5.4 Consideration of Contribution from Ambient Levels of Metals

Because some metal concentrations are known to be higher in the region due to natural mineralization, ambient levels of metals could contribute to the total exposure and risk estimates for the mine site releases. Therefore, it is important to determine what portion of the site concentrations detected is due to the site-related releases, compared to the portion representing ambient for Salt Chuck Mine. Ambient refers to the range of concentrations of the chemical in similar nearby reference areas that have not been affected by the mining activities.

The HHRA will provide ELCR and hazard estimates both for Salt Chuck Mine exposure areas and for ambient exposure areas, for comparative purposes. In addition, the incremental risks or hazards will be estimated as the difference between the Salt Chuck Mine ELCRs or hazards and those from ambient reference area concentration levels. Ambient reference area samples were collected from locations that have no documented or visually apparent active mining activity or impacts near or at the Salt Chuck Mine area

4.5.5 Action Levels for Human Health

For the purposes of the HHRA, the potential for unacceptable human health risk will be identified in accordance with EPA guidance (EPA, 1991b), using the following risk thresholds:

- In interpreting estimates of excess lifetime cancer risks, EPA under the Superfund program generally considers action to be warranted when the multi-chemical aggregate cancer risk for all exposure routes within a specific exposure scenario exceeds 1 x 10^{-4}. Action generally is not required for risks falling within 1 x 10^{-6} and 1 x 10^{-4}; however, this is judged on a case-by-case basis. Under state guidance, ADEC considers a cancer risk exceeding 1×10^{-5} as unacceptable risk.
- Under EPA and ADEC guidance, unacceptable noncancer hazard exists if the multi-chemical aggregate noncancer hazard for all exposure routes within a specific exposure scenario exceeds a target noncancer HI of 1 for toxicants that have similar mechanisms of action.
- If lead concentrations in environmental media result in a predicted blood-lead level of 10 micrograms per deciliter (µg/dL) in greater than 5 percent of the potentially exposed population, lead is present at unacceptable levels.

4.6 Uncertainty Analysis

Risk assessment as a science is subject to uncertainty, both for risk assessment in general and for an understanding of location-specific conditions. Overall uncertainties associated with the human health evaluation pertain to:

- Sampling and analysis
- Fate and transport estimation
- Exposure estimation
- Toxicological data

A qualitative uncertainty analysis for Salt Chuck Mine will be conducted to identify specific causes of uncertainties and evaluate their potential impact on risk estimates. This information will be presented in a summary table for each specific risk assessment step, and will identify the specific source and effect of the uncertainty factor on the resulting risk estimates for the site (i.e., whether the factor tends to over or underestimate calculated risk).

5. Ecological Risk Assessment Methodology

This section describes the methodology for the ERA to be conducted for the Salt Chuck Mine site. The ERA will evaluate the likelihood that adverse ecological effects could occur as a result of exposure to one or more mine-related stressors (EPA, 1992b). The overall objective of the ERA will be to quantitatively and qualitatively evaluate baseline or existing exposure and risks to ecological receptors, and to provide risk managers with information needed to achieve their ecological management goals and help determine remedial decisions, if necessary.

The ERA will characterize the ecological communities at and in the vicinity of the Salt Chuck Mine site, identify complete ecological exposure routes, identify particular hazardous substances of ecological concern, and determine whether ecological exposures are estimated to pose unacceptable risks and therefore may need to be addressed during a Feasibility Study. The ERA will address potential ecological effects affecting habitats and ecological receptors using the Salt Chuck Mine site, including vegetation, terrestrial invertebrates, wildlife (birds and mammals), aquatic life (fish, invertebrates, shellfish), identify potential T&E species using the Salt Chuck Mine site, and other sensitive habitats associated with the Salt Chuck Mine site. The ERA will use multiple lines of evidence, to determine whether any releases at the site could pose unacceptable risk to these ecological receptors.

5.1 Ecological Risk Assessment Guidance

Several guidance documents will be used to provide direction for developing the ERA. These include, but are not limited to, the following:

- *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (EPA, 1997a)
- *Final Guidelines for Ecological Risk Assessment* (EPA, 1998b)
- *Ecological Risk Assessment and Risk Management Principles for Superfund Sites* (EPA, 1999)
- *The Role of Screening-Level Risk Assessments and Refining Contaminants of Concern in Baseline Ecological Risk Assessments* (EPA, 2001)
- *Wildlife Exposure Factors Handbook* (EPA, 1993b)
- *Eco Updates, Volume 1, Numbers 1 through 5* (EPA, 1991c, 1991d, 1992c, 1992d, 1992e)
- *Eco Updates, Volume 2, Numbers 1 through 4* (EPA, 1994a, 1994b, 1994c, 1994d)
- *Eco Updates, Volume 3, Numbers 1 and 2* (EPA, 1996b, 1996c)
- *Conceptual Site Model Policy Guidance* (ADEC, 2010)
- *Draft Risk Assessment Procedures Manual* (ADEC, 2011)
- *Technical Background Document for Selection and Application of Default Assessment Endpoints and Indicator Species in Alaskan Ecoregions* (ADEC, 1999)

5.2 EPA's Risk Assessment Process

The ERA will follow the eight-step approach recommended by EPA (1997a). This process is shown in Figure 8 and is listed as follows:

- **Step 1.** Screening-level problem formulation and ecological effects evaluation
- **Step 2.** Screening-level exposure estimate and risk calculation
- **Step 3.** Baseline risk assessment problem formulation
- **Step 4.** Study design and data quality objective (DQO) process
- **Step 5.** Verification of field sampling plan

- **Step 6.** Site investigation and data analysis
- **Step 7.** Risk characterization
- **Step 8.** Risk management

The process begins with the screening level ecological risk assessment (SLERA) which will use intentionally conservative assumptions to screen the initial list of detected constituents to identify those constituents requiring further evaluation. The principal components of the SLERA are the screening level problem formulation (Step 1), exposure estimation, effects evaluation, and screening level risk calculation (Step 2). If any chemicals of potential ecological concern (COPECs) are present at concentrations that indicate the need for further evaluation, the process is repeated using more site-specific and, generally, less conservative exposure assumptions and a second risk calculation that includes a less conservative toxicity reference value (Step 3, baseline problem formulation). These refined calculations can lead to a decision to conduct additional studies to further refine exposure estimates and effects relationships (Steps 4 through 6) or, through completion of Step 7, serve as the baseline ERA for the site. The final step, Step 8, concludes with risk management decisions.

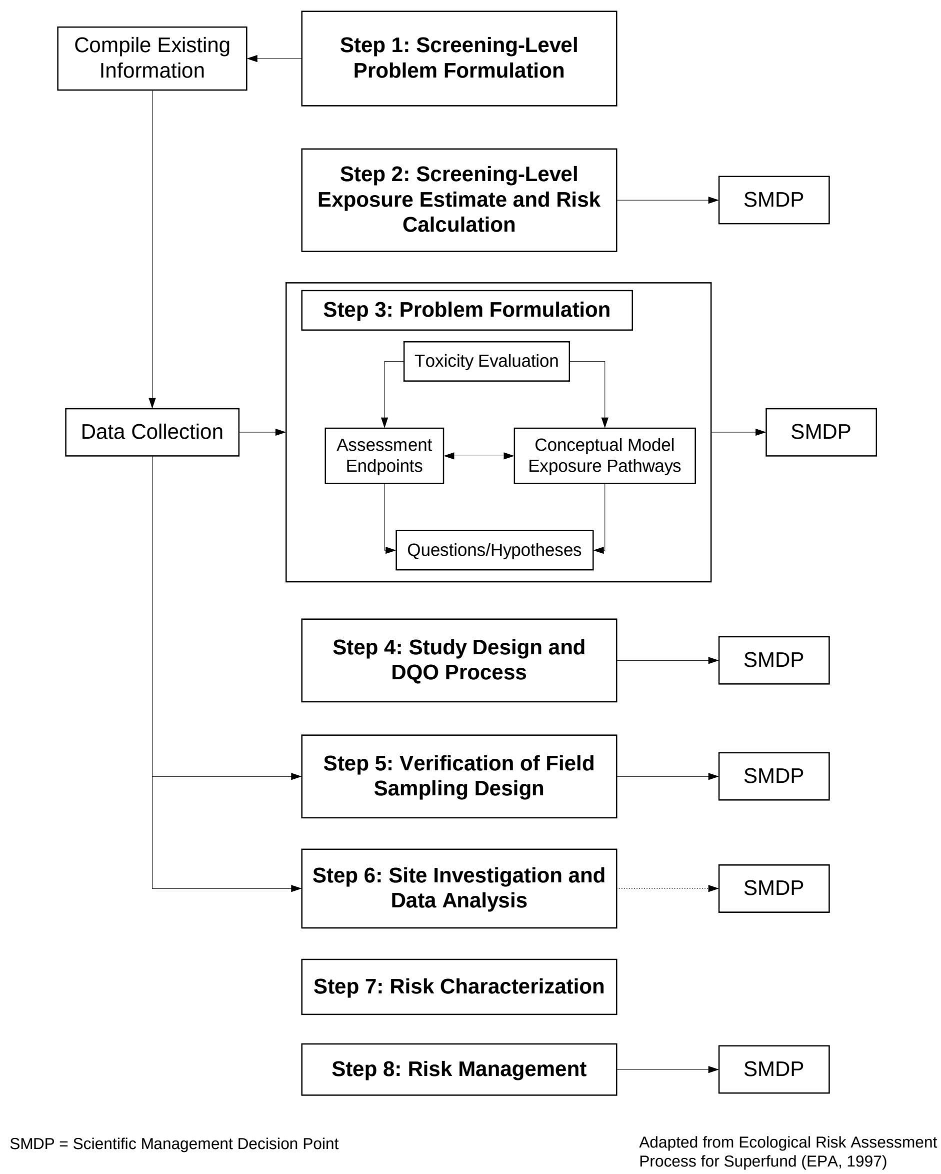


FIGURE 8
EPA's Eight-step Ecological Risk Assessment Process for Superfund
Risk Assessment Work Plan, Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

EPA recognizes that the eight-step approach is not a linear or sequential process and some steps may not be necessary to reach a decision point. Throughout the ERA process, the risk assessment review team, risk managers, and stakeholders will evaluate available information and discuss and agree upon results and future needs of the ERA. This communication between the ecological risk review team and the risk managers is termed the Scientific Management Decision Point (SMDP). It is an integral part of the ERA process. Possible decision points include: (1) no further action is warranted, (2) further evaluation is warranted, (3) additional data are required, or (4) remedial action is warranted.

5.3 Screening Level Problem Formulation (Step 1)

The screening level problem formulation establishes the goals, scope, and focus of the ERA. A description of the environmental setting and a summary of available data are compiled to formulate the CSM. From this information, the exposure pathways, target receptors, and potential effects are determined and serve as the focus for Step 2. Step 1 has been completed as part of this RAWP with the elements described in the CSM (Section 2), including the ecological setting (Section 2.3) and potentially complete ecological exposure pathways and receptors (Section 2.6.4) and those presented in the subsections that follow.

5.3.1 Selection of Representative Endpoint Species

To evaluate ecological exposure, representative endpoint species are selected for the functional feeding guilds identified in the ecological CSM. For example, a belted kingfisher may be considered representative of piscivorous birds visiting the site. Consistent with *Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments, Interim Final* (EPA, 1997a), these endpoint species should preferably be ones that have ecological relevance, are of societal value, are susceptible to chemical stressors at the site, and allow risk managers to meet policy goals. These factors are used to select representative endpoint species common to the Salt Chuck Mine site or adjacent habitats. As described in Section 2 and depicted in Figures 6 and 7, separate conceptual exposure models were developed for intertidal and upland areas. The representative species selected for each feeding guild and habitat type at the Salt Chuck Mine site are as follows:

- Terrestrial and riparian plants—community level
- Intertidal plants—community level
- Terrestrial invertebrates—community level
- Freshwater aquatic biota (fish, amphibians, water column invertebrates, and benthic infauna)—community level
- Marine/estuarine aquatic biota (fish, water column invertebrates, benthic infauna, and epibenthic infauna)—community level
- Upland omnivorous birds— Chestnut-backed Chickadee (*Poecile rufescens*)
- Upland/Intertidal omnivorous mammals—black bear (*Ursus americanus*)
- Upland carnivorous birds —Northern Shrike (*Lanius excubitor*)
- Upland carnivorous mammals—gray wolf (*Canis lupus*)
- Upland/Riparian herbivorous birds—Spruce Grouse (*Falcipennis canadensis*)
- Upland/Riparian herbivorous mammals—Sitka black-tailed deer (*Odocoileus hemionus sitkensis*)
- Riparian insectivorous mammals—dusky shrew (*Sorex monticolus*)
- Piscivorous birds—Belted Kingfisher (*Ceryle alcyon*)
- Piscivorous mammals—mink (*Mustela vison*)

- Invertivorous shorebirds – Western Sandpiper (*Calidris mauri*)
- Herbivorous waterfowl – Mallard (*Anas platyrhynchos*)

Note: Unlike birds and mammals, methods to differentiate exposure and/or effects among different plant, invertebrate, and fish species are largely unavailable. Therefore, individual species are not selected to represent the plant, invertebrate, and fish populations and communities for evaluation.

5.3.2 Assessment and Measurement Endpoints

The conclusion of the screening level problem formulation is the identification of assessment and measurement endpoints. Superfund guidance states that assessment endpoints are any adverse effects on ecological receptors, where receptors are populations and communities, habitats, and sensitive environments (EPA, 1997a). The assessment endpoints for the Salt Chuck Mine site are any adverse effects on receptor populations and communities for non-T&E species. Adverse effects on these assessment endpoints are predicted from measurement endpoints. The measurement endpoints for this site are the effects of chemical exposure on reproduction, survival, or growth, which can be used to predict effects at all levels of organization (individual, population, and community); these factors are considered in the identification and evaluation of appropriate toxicity information.

Assessment endpoints frequently cannot be directly measured because they tend to correspond to complex ecosystem attributes. Because of this, the ERA identifies other related measures that serve as representations or surrogates of each assessment endpoint. These measures are called "measures of effect" and "measures of exposure" (EPA, 1998b). The strength of the relationships between these measures and their corresponding assessment endpoints is critical to the identification of ecological adversity. For this ERA, these measures will be defined as follows:

- Measures of exposure are quantitative or qualitative indicators of a constituent's occurrence and movement in the environment in a way that results in contact with the assessment endpoint. For example, chemical concentrations detected in surface soil serve as a measure of exposure to terrestrial wildlife that could use habitats at the Salt Chuck Mine area.
- Measures of effect are measurable adverse changes in an attribute of an assessment endpoint (or its surrogate) in response to a chemical to which it is exposed. For example, literature-derived critical toxicity values from available laboratory studies on birds are used to indicate when fish-eating birds (as represented by the belted kingfisher) may be adversely affected.

Based on the information gathered during previous investigations and for this RI, the assessment endpoints identified for the Salt Chuck Mine and the corresponding measures of exposure and effect are summarized in Table 8.

5.4 Screening Level Exposure Estimate and Risk Calculation (Step 2)

The screening level risk calculation will be the final step in the SLERA. In this step, the maximum exposure concentrations for each medium will be compared with corresponding, and intentionally conservative ecological screening values (ESVs) to derive screening risk estimates. For example, site-wide maximum media-specific concentrations for all detected constituents will be compared to risk-based screening values without consideration of fraction of time a receptor forages at the Salt Chuck Mine site. If ESVs are unavailable, then the constituents will be carried forward for further evaluation. The ecological screening levels that will be used are described in the following text.

5.4.1 Soil Screening Values

The primary source of soil ESVs that will be used are EPA's ecological soil screening levels (Eco SSLs) (EPA, various dates 2003-2008). Soil ESVs for wildlife represent the lowest of the bird and mammal Eco SSL for each detected constituent. The preferential soil ESVs for terrestrial plants is EPA's Eco SSLs. If no Eco SSLs are available, toxicological benchmarks for terrestrial plants from other literature sources will be used. The preferential sources of soil ESVs for terrestrial invertebrates are also EPA's Eco SSLs.

5.4.2 Surface Water Screening Values

The chronic ESVs that will be used are generally protective for most aquatic receptors that reside in the water column including aquatic plants, water-column invertebrates, amphibians, and fish. Groundwater is not directly accessible to ecological receptors at the Salt Chuck Mine. However, under the assumption that mine-related constituents in groundwater may discharge to surface water where aquatic organisms are present (for example, Salt Chuck Bay), detected constituent concentrations in shallow groundwater will also be screened against ESVs.

Chronic freshwater aquatic ESVs will be selected using the following hierarchy of sources:

- EPA National Recommended Water Quality Criteria (NRWQC) (EPA, 2009b)
- Michigan Department of Environmental Quality Rule 57 value database Freshwater Chronic Values (FCVs) (2009)
- National Oceanic and Atmospheric Administration Screening Quick Reference Tables (that is, SQuiRTs) (Buchman, 2008)

Chronic marine aquatic ESVs will be selected using the following hierarchy of sources:

- EPA NRWQC (EPA, 2009b)
- National Oceanic and Atmospheric Administration SQuiRTs (Buchman, 2008)

5.4.3 Sediment Screening Values

The sediment ESVs that will be used are considered generally protective for most benthic receptors that reside in sediment including benthic microorganisms, benthic invertebrates, and benthic fish. The primary sources that will be used for sediment ESVs are the EPA's Freshwater Sediment Screening Benchmarks available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/fwsed/screenbench.htm and Marine Sediment Screening Benchmarks available at http://www.epa.gov/reg3hwmd/risk/eco/btag/sbv/marsed/screenbench.htm. Additional literature sources of sediment ESVs may include the lowest of the sediment benchmarks reported in the U.S. National Oceanic and Atmospheric Administration Screening Quick Reference Tables (SQuiRTs) from (Buchman, 2008). Wildlife and plants using riparian and intertidal areas are also potentially exposed to chemicals in sediment. Therefore, chemical concentrations in sediment will also be compared with the ESVs used for soil (for example, EPA's Eco SSLs).

5.4.4 Screening Risk Calculation

In this step, the maximum exposure concentrations detected at Salt Chuck Mine area (in each medium) will be compared with the corresponding ESV to derive screening level risk estimates. Detected constituents will be evaluated using the HQ method. HQs will be calculated by dividing the appropriate EPC (for the SLERA; that is, maximum detected concentrations) by corresponding medium-specific ESVs. Constituents with HQs greater than or equal to 1 will be identified as COPECs and carried forward for additional evaluation. Detected constituents for which ESVs are not available will also be carried forward.

5.4.5 Recommendation for SMDP 1

Following Step 2, the first SMDP will occur. This SMDP is intended to communicate the findings of the SLERA and to determine which COPECs, endpoint species, and exposure pathways should be carried forward to Step 3.

5.5 Baseline Ecological Risk Assessment Problem Formulation (Step 3)

Upon completion of the SLERA, a list of COPECs will be derived that will serve to focus the baseline ecological risk assessment (BERA) problem formulation. The BERA begins with a refinement of the COPECs, in which the conservative assumptions used in the SLERA are refined and risk estimates are calculated with exposure models that allow use of more site-specific assumptions. At the conclusion of Step 3, SMDP 2 will be completed.

5.5.1 Refinements to Risk Estimates

Potential effects to plant, invertebrate, and wildlife communities will be assessed using an approach that considers multiple lines of evidence collectively, in accordance with EPA guidance in *Guidelines for Ecological Risk Assessment* (EPA, 1998b). The various lines of evidence may include the following:

5.5.1.1 Lines of Evidence for Plants

1. Soil EPCs will be calculated using EPA's statistical program ProUCL (EPA, 2011b) following the procedures described in Section 4.3.1 of this RAWP. These EPCs will be compared with ESVs for plants.
2. Relative contribution of background levels will be considered.
3. Many plant benchmarks are based on few studies and limited species. Therefore, the confidence level for plant ESVs will be qualitatively discussed.

5.5.1.2 Lines of Evidence for Terrestrial Invertebrates

1. Soil EPCs will be calculated using EPA's statistical program ProUCL. These EPCs will be compared with ESVs for terrestrial invertebrates.
2. Relative contribution of background levels will be considered.
3. Many invertebrate benchmarks are based on few studies and limited species. Therefore, the confidence level for invertebrate ESVs will be qualitatively discussed.

5.5.1.3 Lines of Evidence for Aquatic Organisms

1. Site-specific hardness data will be used to calculate hardness-derived freshwater thresholds.
2. Data collected nearest to exposure points (for example, surface water collected within streams) will be the focus of the BERA.
3. Relative contribution of background levels will be considered.

5.5.1.4 Lines of Evidence for Sediment Infauna

1. Sediment concentrations will be compared with freshwater sediment probable effects concentrations (MacDonald et al., 2000), marine sediment effects range – median (ER-M) levels (Long and Morgan, 1990), or other comparable levels above which adverse effects are likely to occur.
2. Site-specific sediment bioassay results will be considered. During the 2011-2012 RI, sediment toxicity was measured using a 20-day test with polychaetes (*Neanthes arenaceodentata*) and a bivalve embryo-larval development test using a mussel (*Mytilus galloprovincialis*).
3. Site-specific shellfish tissue concentrations will be compared with tissue residue effects in literature.
4. The relative contribution of background will be considered.

5.5.1.5 Lines of Evidence for Wildlife

1. Soil, sediment, and biota EPCs will be calculated using EPA's statistical program ProUCL. These EPCs will be used in refined exposure estimates.
2. Site-specific food chain models will be used to evaluate the exposures and risk to endpoint species representative of those using the habitats at Salt Chuck Mine. Among other things, these models will incorporate site-specific tissue data for food items, site-specific area use factors for each representative endpoint species.
3. Chronic-lowest-observed-adverse-effect levels (LOAELs) will be included to evaluate the range of risk associated with a COPEC in each feeding guild.
4. The relative contribution of background will be considered.

Further lines of evidence may be applied during the concentration-based refinement, which will provide additional information for risk management decision-making, including but not limited to evaluations based on a range of available ESVs, magnitudes of exceedance, spatial variability of COPEC concentrations, or other site-related considerations.

5.5.2 Wildlife Exposure Modeling

The following subsections describe the methods and equations that will be used to compute potential exposure to wildlife in the BERA.

5.5.2.1 Wildlife Dosage-Based Exposure Model

The general exposure model to be used for birds and mammals is based on exposure to contaminants through multiple pathways including soil/sediment, surface water, and food items. To address these multiple pathways, modeling will be required. Exposure estimates for each representative species will be generated according to the following:

- Media of concern
- EPCs for abiotic media
- Receptor-specific exposure factors (or life-history parameters)
- Bioaccumulation potential in food items
- Area use factors

The end product of the BERA exposure estimate is a dosage (milligrams per kilogram receptor body weight per day) rather than a medium concentration (as would be used for the SLERA). This is a function of both the multiple pathway approach and the typical methods used in toxicity testing for birds and mammals. The following generalized exposure model will be used:

$$E_j = \left(S_j \times P_s \times FIR\right) + \left(\sum_{i=1}^{N} B_{ij} \times P_i \times FIR\right) + \left(Water_i \times WIR\right) \times AUF \times MF$$

where:

E_j	=	Total exposure (mg/kg$_{bw}$/day)
S_j	=	Constituent concentration in soil/sediment (mg/kg)
P_s	=	Soil/sediment ingestion rate as a proportion of diet
FIR	=	Total food ingestion rate for the representative species (kg$_{diet}$/kg$_{bw}$-day)
B_{ij}	=	Constituent concentration (j) in biota type (i) (mg/kg)
P_i	=	Proportion of biota type (i) in diet
$Water_j$	=	Constituent concentration in water (mg/L)
WIR	=	Total water ingestion rate for the representative species (L/kg$_{bw}$-day)
AUF	=	Area use factor (fraction of foraging range)
MF	=	Migration factor (fraction of year)

5.5.2.2 Exposure Point Concentrations

EPCs will be developed for each exposure area. Exposure areas will be generally defined as Upland Forest, Riparian/Streams, and Intertidal. EPCs used in the BERA will be calculated using the EPA's ProUCL statistical program (EPA, 2011b) following the procedures described in Section 4.3.1 of this RAWP.

The exposure areas over which investigation data will be aggregated for computation of UCLs will be determined once the 2013 RI investigation activities are complete. Due to the geographic scale of the RI, the spatial representativeness, chemical concentration trends, and numbers of samples will all be considered to decide exposure areas for the risk assessment. For the intertidal area, the mud flats adjacent to the former mill site will likely represent a single exposure area where wildlife could be exposed to sediment, water, or biota. Other areas and media with much lower concentrations of mine-related constituents may be addressed using screening approaches, rather than by computing areally-averaged results for exposure areas.

5.5.2.3 Exposure Factors

Species-specific life history factors are needed to estimate exposure to COPECs for each representative wildlife receptor. These include body weight, food ingestion rates, water ingestion rates, incidental soil or sediment ingestion rates, and diet composition. Species-specific exposure assumptions for estimating wildlife contaminant intake from mine-related COPECs are provided in Table 9. Brief species life history accounts that discuss preferential habitats and food items, foraging area and migration patterns, and breeding habits for each receptor will also be presented in the BERA. The BERA will conservatively assume that COPECs are 100 percent bioavailable to the receptor. Allometric equations will be used to compute food ingestion and water ingestion rates normalized to the wildlife receptor's body weight, with units of kilograms of dry food per kilogram body weight per day or liters of water per kilogram body weight per day, respectively (Nagy, 2001).

5.5.2.4 Bioaccumulation into Food Items

Bioaccumulation can be defined as the uptake and accumulation of chemicals by organisms from the nonliving (abiotic) environment or through the diet. The ERA will evaluate the risk to endpoint species that consume four primary classes of food items (vegetation, fish, invertebrates, and small birds/mammals). Mine-specific COPEC concentrations in food items, measured during the RI, will be used when available. During the RI, upland and intertidal plant tissue and shellfish tissue data have been collected to support the exposure assessments in the BERA. For food items where tissue data have not been directly measured (for example, small mammals), concentrations of a COPEC in those food chain items will be estimated. For these tissues, the partitioning of COPECs from soil, sediment or water to food items will be estimated from literature-reported values or uptake regression models. If site-specific, literature values, or reliable regression models are not available for a given chemical, a default bioaccumulation value of 1 will be used. Medium-specific bioaccumulation factors (BAFs) and bioconcentration factors (BCFs) to be used are described as follows:

- **Plants.** As part of the RI, dry-weight tissue concentrations for COPECs measured in aboveground vegetative portions of upland and intertidal plants collected at Salt Chuck Mine will be used. These will serve as the primary measures of plant uptake used in the exposure models.
- **Terrestrial Invertebrates.** Dry weight tissue concentrations in soil invertebrates (earthworms) will be estimated by multiplying the soil concentration for each chemical by chemical-specific BAFs (single value or regression equation) obtained from the literature. BAFs based on depurated analyses (soil is purged from the gut of the earthworm before analysis) are given preference over non-depurated analyses when selecting BAF values, because direct ingestion of soil is accounted for separately in the food-web model.
- **Small Mammals.** Whole-body tissue concentrations in small mammals (shrews, voles, and/or mice) will be estimated using soil-to-small-mammal BAFs. Tissue concentrations will be calculated by multiplying the surface soil concentration for each chemical by a chemical-specific, soil-to-small-mammal BAF (single value or regression equation) obtained from the literature. The BAF values used are based on the ratio between dry-weight soil and whole-body dry-weight tissue.
- **Benthic Invertebrates.** Tissue concentrations in benthic invertebrates will be estimated by multiplying the sediment concentration for each chemical by chemical-specific, sediment-to-invertebrate BAFs obtained from the literature. The BAF values used are based on the ratio between dry-weight sediment and dry-weight invertebrate tissue. In some cases, shellfish tissue data from the RI may be directly used in lieu of modeling into benthic invertebrate tissue, for purposes of estimating exposure to higher consumers of the invertebrates.
- **Fish/Shellfish.** As part of the RI, dry-weight tissue concentrations for COPECs measured in whole clams, crabs, and shrimp (excludes shells) collected in Salt Chuck Bay will be used. These will serve as the primary measures of fish and shellfish uptake used in the exposure models. A secondary approach could also be used where tissue concentrations in whole-body fish are estimated by multiplying the surface water concentration for each COPEC by BCFs obtained from the literature (primarily from values used for derivation of EPA's National Ambient Water Quality Criteria [NAWQC][EPA, 2002c]). These BCF values are based on the ratio between surface water and wet-weight fish tissue and would require a conversion to a dry-weight basis by dividing the wet-weight BCF by the estimated solids content for fish (25 percent [0.25]) (EPA, 1993b).

5.5.2.5 Area Use Factors

Many wildlife species are highly mobile, covering relatively large areas in search of food, water, and shelter. As such, the exposure that individual receptors experience depends on the amount of time they spend at a contaminated site. The area use factor (AUF) is a ratio of the size of a site (or exposure area) relative to an animal's foraging range using the following equation. This value is incorporated in the exposure model to give a more realistic estimation of overall exposure.

$$AUF = \frac{Exposure\ Area}{FR_x}$$

where:

AUF	=	Area use factor
Exposure Area	=	Contaminated area or habitat type (acres)
FR_x	=	Foraging range for target species x (acres)

AUFs will be derived for each exposure area defined, based on its size. If the receptor's foraging range is less than the size of the exposure area, an AUF of 1 will be assumed.

5.5.2.6 Consideration of Endpoint Species Migration

The migration factor (MF) is a species-specific temporal adjustment that accounts for migratory habits. It is the fraction of the year that the species is expected to be in the general area of the Salt Chuck Mine. Based on the life history information to be gathered for each endpoint species, migration factors may be applied for the endpoint species which are not expected to be present year-round.

5.5.3 Wildlife Ecological Effects Assessment

The ecological effects assessment will identify the toxicity associated with the chemical stressors at Salt Chuck Mine. It will determine the type and level of effect that could result to the receptor if exposure is excessive. Stressor-response (that is, effects) data that can be used to evaluate ecological risks resulting from chemical exposures originate from three general sources: literature-derived single-chemical toxicity data, site-specific ambient media toxicity tests, and site-specific field surveys (Suter et al., 2000). In most cases, single-chemical toxicity data found in the literature will be used as the basis for the ESVs and toxicity reference values (TRVs) for the BERA. For evaluation of sediment-dwelling invertebrates, laboratory toxicity test data will be used to directly measure adverse effects.

5.5.3.1 Mammalian and Avian Effects

A literature review of the toxicological properties for COPECs will be conducted to identify the highest exposure level considered to be without adverse ecological impact. This exposure level will be referred to as the TRV. The primary toxicological endpoint used for the development of the TRV is the chronic-no-observed-adverse-effect level (NOAEL) (in units of mg/kg body weight-day). Chronic-LOAELs are also used to develop secondary TRVs in order to further evaluate the range of risk associated with a COPEC in each feeding guild. TRVs will be derived by interpreting existing toxicology studies and adjusting those data, if necessary, to obtain values that are expected to protect the selected endpoint species. Literature references citing use of laboratory animals that have similar sensitivity, life history, or habitat requirements will be used as surrogates for the wildlife ecological receptor species. Toxicity data then will be adjusted for the uncertainty associated with differences between the laboratory tests and the receptor in the environment.

Derivation of wildlife TRVs for the endpoint species will involve the following three-step process:

1. Conducting a literature search to compile data on toxicity of the COPECs to surrogate (laboratory test) species.
2. Reviewing these toxicity data to select the most appropriate values for each COPEC.
3. Applying uncertainty factors from the toxicology literature to derive a chronic, NOAEL, or LOAEL, from other endpoints (for example, subchronic studies) if necessary.

The primary sources of wildlife TRVs for the BERA will be the EPA's Eco SSLs (EPA, various dates 2003-2008). Additional sources for ecological toxicity information may include but are not limited to the following:

- Los Alamos National Laboratory Toxicity Database (2012)
- U.S. Army Center for Health Promotion and Preventive Medicine Wildlife Toxicity Database (2009)
- Oak Ridge National Laboratory Wildlife TRVs (Sample et al., 1996)
- Navy Biological Technical Assistance Group TRVs (Engineering Field Activity West, 1998)
- Agency for Toxic Substances and Disease Registry Toxicological Profiles (2012)
- Integrated Risk Information System (IRIS) (EPA, 2013)
- Other peer-reviewed scientific sources

When necessary, uncertainty factors will be applied to the literature-derived toxic level to account for any differences in the reported effect level or exposure duration, in accordance with the EPA Region 10 guidance (EPA, 1997b) and with ADEC's *Risk Assessment Procedures Manual* (ADEC, 2011).

5.5.4 Risk Characterization Methodology

Risk characterization is a way of quantitatively or qualitatively characterizing the potential risks for each COPEC and receptor identified in the COPEC screening process. The primary means of characterizing ecological risk for wildlife is to determine the ratio of the estimated chemical exposure level or dose for the wildlife receptor with the COPEC-specific TRV. Hazard quotients can be calculated to quantitatively characterize these risks. The following equation will be used:

$$HQ = \frac{E_j}{TRV}$$

where:

HQ	=	Ecological hazard quotient (unitless)
E_j	=	Estimated COPEC exposure (mg/kg$_{bw}$-day)
TRV	=	Toxicity reference value (mg/kg$_{bw}$-day)

The primary means for quantifying ecological risk for plants, aquatic organisms, terrestrial invertebrates, and sediment infauna is to determine the ratio of the estimated COPEC exposure levels for the endpoint species of concern with the COPEC-specific ecological benchmark criterion.

$$HQ = \frac{EPC}{ESV}$$

where:

HQ	=	Ecological hazard quotient (unitless)
EPC	=	Exposure point concentration (mg/kg or mg/L)
ESV	=	Ecological screening value criterion (mg/kg or mg/L)

The HQ estimates will be expressed in one significant figure, in accordance with EPA and ADEC guidance. A HQ that exceeds 1 indicates that there is a potential for adverse ecological effects associated with exposure to that COPEC and further evaluation of remedial actions may be warranted. A HQ value less than or equal to 1 is considered protective of each receptor's feeding guild that it represents because it is developed using conservative exposure assumptions. HQs will be provided using both NOAEL-based and LOAEL-based TRVs.

5.5.5 Uncertainties

Uncertainties are inherent in all ecological risk assessments because of the limitations of the available data and the need to make certain assumptions and extrapolations based on incomplete information. In addition, the use of various models (for example, uptake and food web exposures) carries with it some associated uncertainty as to how well the model reflects actual conditions. However, because conservative assumptions are generally used throughout the exposure and effects assessments, these uncertainties are more likely to result in an overestimation rather than an underestimation of the likelihood and magnitude of risks to ecological receptor. The uncertainties and limitations associated with the proposed methodology and available data for the ERA will be discussed in the risk assessment.

5.5.6 Recommendation for SMDP 2

Following Step 3, SMDP 2 will occur and recommendations on the path forward will be described. If the SMDP 2 does not recommend that data are insufficient and no additional sampling, is warranted, then the eight step ERA process ends here and the results of the ERA are carried into the FS. The risk assessment would provide information necessary for identifying remedial action goals and any remedial action alternatives would be presented in the FS.

6. Risk Assessment Report

The results of the baseline HHRA and ERA for the Salt Chuck Mine site will be provided in a risk assessment report in a format consistent with EPA guidelines. This report will be submitted to in accordance with an agreed upon schedule. The results of the risk assessment will be presented in a clear and consistent fashion in the risk assessment report.

The risk assessment conclusions will be designed to provide meaningful data to risk managers to be applied during the decision-making process. Once the exposure and risk estimates are complete, the collective weight of evidence will be evaluated, in consultation with the EPA and other stakeholders, to determine the likelihood that unacceptable risk exists. A concise set of conclusions will be provided using a weight-of-evidence approach and with consideration of the uncertainties in the analysis. By evaluating multiple lines of evidence collectively, more confidence in a conclusion of unacceptable risk can be obtained. For the ERA, some lines of evidence (such as bioassay results) will inherently carry more "weight" than others (such as ESV exceedance levels).

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Tables

Table 1

2009-2011 Climate Summary for Craig, Alaska

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Month	Mean Temperature (^oF)	Maximum Temperature (^oF)	Minimum Temperature (^oF)	Total Precipitation (inches)	Total Snowfall (inches)
2009					
Jan	35.9	60	12	11.05	11.1X
Feb	34.5	52	18	6.24	1.6X
Mar	35.6	48	18	6.03	12
Apr	42	70	28	5.28	0.0
May	49.2	74	36	3.46	0.0
Jun	54.7	81	41	3.96	0.0
Jul	59.2	75	46	1.22	0.0
Aug	58.4	75	47	5.98	0.0
Sep	54	70	36	13.76	0.0
Oct	47.3X	61	31	10.98	0.0
Nov	40.8	54	29	12.99	0.8
Dec	34.5	49	19	3.06	0.7
Annual	45.5	81	12	84.01	26.2*
2010					
Jan	41.2	53	19	7.51	0.8
Feb	41.3	57	28	3.69	0.0
Mar	39.6	53	29	16.27	1.1X
Apr	42.3	58	29	6.63	3.8
May	50	69	33	2.98	0.0
Jun	52.7	65	42	5.3	0.0
Jul	56.1	75	47	3.68	0.0
Aug	57.9	77	49	3.92	0.0
Sep	55.2	75	39	9.3	0.0
Oct	47.0X	65	31	16.14	0.0
Nov	40.3	58	23	13.52	1.0
Dec	37.6	52	20	5	2.3X
Annual	46.8	77	19	93.94	9.0*
2011					
Jan	36.6	48	15	8.35	3.5
Feb	34.4	48	13	6.49	4.1
Mar	38	58	10	5	0.6
Apr	41.6	58	31	6.71	0.3
May	48.2	67	36	4.99	0.0
Jun	53.9	72	44	2.11	0.0
Jul	54.8	70	45	4.84	0.0
Aug	NA	68	45	12.35	0.0
Sep	53.4	68	38	18.16	0.0
Oct	46.9	59	37	14.43	0.0
Nov	37.9	48	26	12.37	11.4X
Dec	38.4	48	26	9.02	5.2
Annual	40.3	72	10	104.82	25.1*

Notes:

Source: National Oceanic and Atmospheric Administration National Climate Data Center (NOAA, 2012)

Station: COOP:502227, CRAIG, AK. Elevation 43 feet above sea level. Lat. 55.477°, Lon. -133.141°

X = Monthly means or totals based on incomplete time series. 1 to 9 days are missing. Annual means or totals include one or more months which had 1 to 9 days that were missing.

* = Annual value missing; summary value computed from available month values.

NA = not available

Table 2

Marine Intertidal Invertebrates Potentially Occurring at Prince of Wales Island

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Common Name	Scientific Name	Feeding Habits	Habitats
Lugworm	*Abarenicola pacifica*	Omnivorous	Marine/ intertidal/subtidal
Black chiton	*Katherina tunicata*	Herbivorous	Marine/ intertidal/subtidal
Gumboot chiton	*Cryptochiton stelleri*	Herbivorous	Marine/ intertidal/subtidal
Lined chitons	*Tonicella lineata*	Herbivorous	Marine/ intertidal
	T. insignus	Herbivorous	Marine/ intertidal
Moss chiton	*Mopalia spp.*	Herbivorous	Marine/ intertidal
Limpets	*Acmaea mitra*	Herbivorous	Marine/ intertidal
	Notoacmea scutum	Herbivorous	Marine/ intertidal
	Notoacmea persona	Herbivorous	Marine/ intertidal
Snails	*Littorina scutulata*	Herbivorous	Marine/ intertidal
	Littorina sitkana	Herbivorous	Marine/ intertidal
	Lacuna carinata	Herbivorous	Marine/ intertidal
	Natica clausa	Carnivorous	Marine/ intertidal/subtidal
	Fusitrition oregonensis	Carnivorous	Marine/ intertidal/subtidal
	Neptunia lyrata	Carnivorous	Marine/ intertidal/subtidal
Blue mussel	*Mytilus trossulus*	Filter feeder	Marine/ intertidal
Horse mussel	*Modiolus modiolus*	Filter feeder	Marine/subtidal
Littleneck clam	*Protothacea staminea*	Filter feeder	Marine/ intertidal/subtidal
Butter clam	*Saxidomus giganteus*	Filter feeder	Marine/ intertidal/subtidal
Softshell clam	*Mya arenaria*	Filter feeder	Marine/ intertidal/subtidal
Acorn barnacle	*Balanus glandula*	Filter feeder	Marine/ intertidal
Thatched barnacle	*Semibalanus cariosus*	Filter feeder	Marine/ intertidal
Dungeness crab	*Cancer magister*	Carnivorous	Marine/ intertidal/ subtidal
Helmet crab	*Telmessus cheiragonus*	Carnivorous	Marine/ intertidal/ subtidal
Rock crab	*Cancer productus*	Carnivorous	Marine/ intertidal/ subtidal
Tanner crab	*Chionoecetes bairdi*	Carnivorous	Marine/ subtidal
Ochra sea star	*Piaster ochraceus*	Carnivorous	Marine/ intertidal/subtidal
Sun star	*Pycnopodia helianthoides*	Carnivorous	Marine/ intertidal/subtidal
Mottled star	*Evasterias troschelii*	Carnivorous	Marine/ intertidal/subtidal
Green sea urchin	*Stongylocentrotus droebachiensis*	Herbivorous	Marine/ intertidal/subtidal
Red sea urchin	*Strongylocentrotus franciscanus*	Herbivorous	Marine/ subtidal

Table 3

Fish and Amphibian Species Potentially Occurring at Prince of Wales Island

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Common name	Scientific name	Group	Feeding Habits	Habitat
Arrowtooth flounder	*Atheresthes stomias*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Chinook salmon	*Onchorynchus tshawytscha*	Anadromous	Carnivorous	Nearshore marine/freshwater streams
Chum salmon	*Onchorhynchus keta*	Anadromous	Carnivorous	Nearshore marine/freshwater streams
Coho salmon	*Onchohynchus kisutch*	Anadromous	Carnivorous	Nearshore marine/freshwater streams
Cutthroat trout	*Oncorhynchus clarki*	Anadromous	Carnivorous	Inshore marine/freshwater streams
Dolly Varden	*Salvalinus malma*	Anadromous	Carnivorous	Inshore marine/freshwater lakes and streams
Pacific cod	*Gadus macrocephalus*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Pacific halibut	*Hippoglossus stenolepis*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Pacific herring	*Clupea harengus*	Marine	Carnivorous	Offshore/inshore marine
Pink salmon	*Oncorhynchus gorbuscha*	Anadromous	Carnivorous	Nearshore marine/freshwater streams
Red Irish Lord	*Hemilepidotus hemilepidotus*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Rock Sole	*Lepidosetta bilineata*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Sablefish (black cod)	*Anaplopoma fimbria*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Slimy Sculpin	*Cottus cognatus*	Marine	Carnivorous	Intertidal/inshore marine
Sockeye salmon	*Oncorhynchus nerka*	Anadromous	Carnivorous	Inshore marine/freshwater lakes and streams
Starry flounder	*Platicthys stellatus*	Marine	Carnivorous	Inshore marine
Steelhead trout	*Oncorhynchus mykiss*	Anadromous	Carnivorous	Inshore marine/freshwater streams
Walleye pollock	*Theragra chalcogramma*	Marine	Carnivorous	Inshore sand-gravel
Yellowfin sole	*Limanda aspera*	Marine	Carnivorous	Offshore rocky/inshore sand-gravel
Roughskin newt	*Taricha granulosa*	Amphibian	Carnivorous	Streams/grassland/forest/muskeg
Western toad	*Bufo boreas*	Amphibian	Carnivorous	Streams/grassland/forest/muskeg
Wood frog	*Rana sylvatica*	Amphibian	Carnivorous	Streams/grassland/forest/muskeg

Table 4

Bird Species Potentially Occurring at Prince of Wales Island

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Common Name	Scientific Name	Feeding Habits	Habitat
Alder Flycatcher	*Empidonax alnorum*	Insectivorous	Stream banks/mixed deciduous-coniferous
American Robin	*Turdus migratorius*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
American Wigeon	*Anus americana*	Omnivorous	Rivers/lakes/estuaries
Bald Eagle	*Haliaeetus leucocephalus*	Carnivorous/scavenger	Coniferous forests
Barn Swallow	*Hirundo rustica*	Insectivorous	Rivers/lakes/estuaries
Barrow's Goldeneye	*Bucephala islandica*	Carnivorous	Lakes/nearshore marine
Belted Kingfisher	*Ceryle alcyon*	Carnivorous	Rivers/lakes/estuaries
Black Scoter	*Melanitta americana*	Insectivorous	Lakes/nearshore marine
Black Turnstone	*Arenaria melanocephala*	Carnivorous	Intertidal
Black-bellied Plover	*Pluvialis squatarola*	Insectivorous	Lakes/nearshore marine
Black-capped Chickadee	*Poecile atricapillus*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Blackpoll Warbler	*Setophaga striata*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Boreal Chickadee	*Poecile hudsonicus*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Boreal Owl	*Aegolius funereus*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Brant	*Branta bernicla*	Herbivorous	Lakes/intertidal wetlands
Brown Creeper	*Certhia americana*	Insectivorous	Coniferous forests
Bufflehead	*Bucephala albeola*	Carnivorous	Lakes/nearshore marine
Canada Goose	*Branta canadensis*	Herbivorous	Lakes/intertidal wetlands
Chestnut-backed Chickadee	*Poecile rufescens*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Chipping Sparrow	*Spizella passerina*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Common Goldeneye	*Bucephala clangula*	Insectivorous	Lakes/nearshore marine
Common Loon	*Gavia immer*	Piscivorous	Lakes/nearshore marine
Common Merganser	*Mergus merganser*	Piscivorous	Lakes/streams
Common Raven	*Corvus corax*	Omnivorous/scavenger	Coniferous/mixed deciduous- coniferous forests
Common Yellowthroat	*Geothlypis trichas*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Dark-eyed Junco	*Junco hyemalis*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Double-crested Cormorant	*Phalacrocorax auritus*	Piscivorous	Lakes/streams
Downy Woodpecker	*Picoides pubescens*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Dunlin	*Calidris alpina*	Carnivorous	Coastal mudflats/sandy beaches
Fox Sparrow	*Passerella iliaca*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Glaucous-winged Gull	*Larus glaucescens*	Carnivorous/scavenger	Inshore/offshore/intertidal
Golden-crowned Kinglet	*Regulus satrapa*	Carnivorous	Coniferous forests
Golden-crowned Sparrow	*Zonotrichia atricapilla*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Gray Jay	*Perisoreus canadensis*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	Herbivorous	Cliffs/rock piles
Great Blue Heron	*Ardea herodias*	Carnivorous	Lakes/intertidal waters
Greater Scaup	*Aythya marila*	Insectivorous	Rivers/lakes/estuaries
Greater Yellowlegs	*Tringa melanoleuca*	Carnivorous	Muskegs
Green-winged Teal	*Anas crecca*	Herbivorous	Lakes/intertidal wetlands
Hairy Woodpecker	*Picoides villosus*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Harlequin Duck	*Histrionicus histrionicus*	Carnivorous	Inshore/offshore/intertidal
Hermit Thrush	*Catharus guttatus*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Herring Gull	*Larus argentatus*	Carnivorous/scavenger	Inshore/offshore/intertidal
Hooded Merganser	*Lophodytes cucullatus*	Piscivorous	Lakes/inshore marine waters
Horned Grebe	*Podiceps auritus*	Piscivorous/insectivorous	Lakes/inshore marine waters
Least Sandpiper	*Calidris minutilla*	Insectivorous	Muskegs
Lesser Yellowlegs	*Tringa flavipes*	Insectivorous	Lakes/intertidal waters
Lincoln's Sparrow	*Melospiza lincolnii*	Herbivorous	Shrub communities/grasslands
MacGillivray's Warbler	*Geothlypis tolmiei*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Mallard	*Anas platyrhynchos*	Omnivorous	Lakes/inshore marine waters
Marbled Murrelet	*Brachyramphus marmoratus*	Carnivorous	Inshore/offshore/intertidal
Merlin	*Falco columbarius*	Carnivourous	Coniferous forests
Mew Gull	*Larus canus*	Carnivorous	Inshore/offshore/intertidal
Northern Flicker	*Colaptes auratus*	Insectivorous	Coniferous/mixed deciduous- coniferous forests

Table 4

Bird Species Potentially Occurring at Prince of Wales Island

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Common Name	Scientific Name	Feeding Habits	Habitat
Northern Hawk Owl	*Surnia ulula*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Northern Pintail	*Anas acuta*	Omnivorous	Lakes/intertidal waters
Northern Saw-whet Owl	*Aegolius acadicus*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Northern Shoveler	*Anas clypeata*	Omnivorous	Lakes/intertidal wetlands
Northern Waterthrush	*Parkesia noveboracensis*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Northwestern Crow	*Corvus caurinus*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Olive-sided Flycatcher	*Contopus cooperi*	Insectivorous	Coniferous forests
Orange-crowned Warbler	*Vermivora celata*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Pacific Loon	*Gavia pacifica*	Carnivorous	Lakes/inshore and offshore marine waters
Pacific Wren	*Troglodytes pacificus*	Carnivorous	Coniferous forests
Pacific-slope Flycatcher	*Empidonax difficilis*	Carnivorous/Insectivorous	Coniferous/mixed deciduous- coniferous forests
Pelagic Cormorant	*Phalacrocorax pelagicus*	Carnivorous/Picivorous	Inshore/offshore marine waters
Pine Grosbeak	*Pinicola enucleator*	Herbivorous	Coniferous forests
Pine Siskin	*Carduelis pinus*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Red Crossbill	*Loxia curvirostra*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Red-breasted Merganser	*Mergus serrator*	Piscivorous	Lakes/nearshore marine
Red-breasted Nuthatch	*Sitta canadensis*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Red-breasted Sapsucker	*Sphyrapicus ruber*	Carnivorous/Insectivorous	Coniferous/mixed deciduous- coniferous forests
Red-eyed Vireo	*Vireo olivaceus*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Red-necked Grebe	*Podiceps grisegena*	Carnivorous	Nearshore marine/lakes and streams
Red-throated Loon	*Gavia stellata*	Piscivorous	Lakes/inshore and offshore marine waters
Ring-necked Duck	*Aythya collaris*	Omnivorous	Lakes/nearshore marine
Ruby-crowned Kinglet	*Regulus calendula*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Rufous Hummingbird	*Selasphorus rufus*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Savannah Sparrow	*Passerculus sandwichensis*	Herbivorous	Coniferous/mixed deciduous- coniferous forests
Semipalmated Plover	*Charadrius semipalmatus*	Insectivorous	Nearshore/Intertidal
Sharp-shined Hawk	*Accipiter striatus*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Short-billed Dowitcher	*Limnodromus griseus*	Insectivorous	Muskegs
Song Sparrow	*Melospiza melodia*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Spruce Grouse	*Falcipennis canadensis*	Herbivorous	Coniferous forests
Steller's Jay	*Cyanocitta stelleri*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Surf Scoter	*Melanitta perspicillata*	Carnivorous	Inshore/offshore/intertidal
Surfbird	*Aphriza virgata*	Insectivorous	Nearshore/Intertidal
Swainson's Thrush	*Catharus ustulatus*	Omnivorous	Coniferous forests
Tennessee Warbler	*Oreothlypis peregrina*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Townsend's Solitaire	*Myadestes townsendi*	Omnivorous	Coniferous forests
Townsend's Warbler	*Dendroica townsendi*	Insectivorous	Coniferous forests
Tree Swallow	*Tachycineta bicolor*	Carnivorous/Insectivorous	Coniferous/mixed deciduous- coniferous forests
Trumpeter Swan	*Cygnus buccinator*	Herbivorous	Inshore marine waters
Varied Thrush	*Ixoreus naevius*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
Violet-green Swallow	*Tachycineta thalassina*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Warbling Vireo	*Vireo gilvus*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Western Sandpiper	*Calidris mauri*	Insectivorous	Lakes/intertidal waters
Western Screech Owl	*Megascops kennicottii*	Carnivorous	Coniferous/mixed deciduous- coniferous forests
Whimbrel	*Numenius phaeopus*	Insectivorous	Nearshore/Intertidal
White-crowned Sparrow	*Zonotrichia leucophrys*	Omnivorous	Coniferous/mixed deciduous- coniferous forests
White-winged Crossbill	*Loxia leucoptera*	Herbivorous	Coniferous forests
White-winged Scoter	*Melanitta fusca*	Piscivorous/insectivorous	Lakes/inshore marine waters
Wilson's Warbler	*Wilsonia pusilla*	Insectivorous	Coniferous/mixed deciduous- coniferous forests
Yellow Warbler	*Setophaga petechia*	Insectivorous	Riparian areas/wetlands
Yellow-rumped Warbler	*Dendroica coronata*	Insectivorous	Coniferous/mixed deciduous- coniferous forests

Source: Melissa Cady, Wildlife Biologist Prince of Wales Zone, Tongass National Forest

Table 5

Terrestrial and Marine Mammals Potentially Occurring at Prince of Wales Island

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Common Name	Scientific Name	Feeding Habits	Habitat
Terrestrial Mammals			
American Marten	*Martes americana*	Carnivorous	Coniferous forests
American Mink	*Neovison vison*	Carnivorous	Coniferous forests along streams
Beaver	*Castor canadensis*	Herbivorous	Streams and lakes in mixed deciduous-coniferous fores
Black bear	*Ursus americanus*	Omnivorous	Coniferous forests
California myotis	*Myotis californicus*	Carnivorous/ insectivorous	Caves/mine tunnels/tree cavities
Dusky shrew	*Sorex monticolus*	Insectivorous	Muskegs/coniferous forests/dry hillsides
Ermine	*Mustela erminea*	Carnivorous	Coniferous forests
Gray wolf	*Canis lupis*	Carnivorous	Coniferous forests
House mouse	*Mus musculus*	Omnivorous	Coniferous/mixed deciduous-coniferous forests
Keen’s myotis	*Myotis keenii*	Carnivorous/ insectivorous	Caves/mine tunnels/tree cavities
Keen's mouse	*Peromyscus keeni*	Granivorous	Coniferous/mixed deciduous-coniferous forests
Little brown bat	*Myotis lucifigus*	Carnivorous/ Insectivorous	Caves/mine tunnels/tree cavities
Long-legged myotis	*Myotis volans*	Carnivorous/ insectivorous	Caves/mine tunnels/tree cavities
Long-tailed vole	*Microtus longicaudus*	Herbivorous	Coniferous/mixed deciduous-coniferous forests
Northern flying squirrel	*Glaucomys sabrinus*	Herbivorous	Coniferous/mixed deciduous-coniferous forests
Norway rat	*Rattus norvegicus*	Omnivorous	Coniferous/mixed deciduous-coniferous forests
River otter	*Lontra canadensis*	Carnivorous	Coniferous forests
Sitka black-tailed deer	*Odocoileus hemionus sitkensis*	Herbivorous	Coniferous forest/alpine/subalpine
Marine Mammals			
Dall’s porpoise	*Phocoenoides dalli*	Piscivorous	Nearshore/offshore marine
Gray whale	*Eschrichtius robustus*	Carnivor	Offshore marine
Harbor porpoise	*Phocoena phocoena*	Piscivorous	Nearshore/offshore marine
Harbor seal	*Phoca vitulina*	Piscivorous	Nearshore/gravel beaches and rocky shores (haulouts)
Humpback whale	*Megaptera novaeangliae*	Planktivorous	Nearshore/offshore marine
Killer whale	*Orcinus orca*	Piscivorous	Nearshore/offshore marine
Minke whale	*Balaenoptera acutorostrata*	Planktivorous	Nearshore/offshore marine
Pacific white-sided dolphin	*Lagenorhynchusobliquidens*	Piscivorous	Offshore marine
Sea otter	*Enhydra lutris*	Piscivorous	Nearshore/offshore marine
Steller's sea lion	*Eumetopias jubatus*	Piscivorous	Offshore/rocky shores (haulouts)

Table 6

Exposure Assumptions for the Human Health Risk Assessment

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Exposure Parameter	Units	Intermittent or Seasonal Worker	Source	Recreational User	Source	Customary/Traditional User	Source
Exposure Concentration (soil/sediment)	mg/kg-dry	95% UCL of mean	a	95% UCL of mean	a	95% UCL of mean	a
Exposure Concentration (surface water)	ug/L	--	--	95% UCL of mean	a	95% UCL of mean	a
Exposure Concentration (shellfish tissue)	mg/kg-wet	--	--	95% UCL of mean	a	95% UCL of mean	a
Adult Body Weight	kg	70	b	70	b	70	b
Child Body Weight	kg	--	--	15	b	15	b
Exposure Frequency	days/yr	125	c	TBD	--	TBD	--
Adult Exposure Duration	yrs	25	b	24	b	24	b
Child Exposure Duration	yrs	--	--	6	b	6	b
Inhalation Exposure Time Fraction	unitless	0.33	d	0.17	d	0.17	d
Carcinogenic Averaging Time	yrs	70	b	70	b	70	b
Noncarcinogenic Averaging Time	yrs	25	b	30	b	30	b
Adult Incidental Soil/Sediment Ingestion Rate	mg/day-dry	100	b	100	b	100	b
Child Incidental Soil/Sediment Ingestion Rate	mg/day-dry	--	--	200	b	200	b
Adult Water Ingestion Rate	L/day	--	--	0.05	e	0.05	e
Child Water Ingestion Rate	L/day	--	--	0.05	e	0.05	e
Wild Food Consumption Rate	g/day-wet	--	--	TBD	--	TBD	--
Adult Skin Surface Area (soil)	cm^2	3,300	f	5,700	f	5,700	f
Child Skin Surface Area (soil)	cm^2	--	--	2,800	f	2,800	f
Adult Skin Surface Area (water)	cm^2	--	--	18,000	f	18,000	f
Child Skin Surface Area (water)	cm^2	--	--	6,600	f	6,600	f
Dermal Absorption Fraction (from soil/sediment)	unitless	Chemical-specific	f	Chemical-specific	f	Chemical-specific	f
Dermal Permeability Coefficient (water)	cm/hr	--	--	Chemical-specific	f	Chemical-specific	f
Adult Event Duration (water)	hr/event	--	--	1.0	g	1.0	g
Child Event Duration (water)	hr/event	--	--	1.0	g	1.0	g
Adult Soil-to-Skin Adherence Factor	mg/cm^2	0.2	f	0.07	f	0.07	f
Adult Sediment-to-Skin Adherence Factor	mg/cm^2	--	--	0.3	f,h	0.3	f,h
Child Soil-to-Skin Adherence Factor	mg/cm^2	--	--	0.2	f	0.2	f
Child Sediment-to-Skin Adherence Factor	mg/cm^2	--	--	3.3	f,h	3.3	f,h
Particulate Emission Factor	m^3/kg	1.32E+09	i	1.32E+09	i	1.32E+09	i
Volatilization Factor	m^3/kg	Chemical-specific	i	Chemical-specific	i	Chemical-specific	i

Notes:

TBD - to be determined prior to the risk assessment
cm^2 - square centimeters
days/yr - days per year
kg - kilograms
m^3/kg - cubic meters per kilogram
UCL - upper confidence limit

mg/cm^2 - milligrams per square centimeter
mg/day - milligrams per day
mg/kg - milligrams per kilogram
mg/L- milligrams per liter
yrs - years

a. Based on 2011, 2012, and 2013 RI sampling
b. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual. Supplemental Guidance: Standard Default Exposure Factors (EPA 1991a)

c. Based on the assumption that mining operations in remote Alaska may hypothetically use a two-weeks-on and two-weeks-off work schedule (Personal communication, Anne Marie Palmieri/ADEC February 2013). In addition to the hypothetical future worker scenario, a reasonable current case worker scenario (e.g., forester) may be included to inform risk management decisions.

d. Fraction of exposure time applied to calculation of inhalation risk (worker equates to 8 hr/day, recreational/subsistence user equates to 4 hr/day)

e. Risk Assessment Guidance for Superfund, Volume 1, Human Health Evaluation Manual (Part A), Interim Final (EPA 1989). Exposure estimates will be based on unfiltered water sample results

f. Risk Assessment Guidance for Superfund, Volume I: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment) Final (EPA 2004). Surface areas are based on whole body for water, and head, hands, forearms, and lower legs for soil/sediment.

g. Professional judgment. Assumes a one-hour swimming or contact event per day.

h. From Exhibit 3-3 in EPA 2004. Value for residential adults as gardeners and value for children playing in wet soil

i. Soil Screening Guidance: Users Guide (EPA 1996a).

Table 7
Toxicity Factors for the Human Health Risk Assessment
Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska
Risk Assessment Work Plan

Analyte	CASRN	Mutagen (Y/N)	Water Permeability Constant (Kp) (cm/hr)	Volatilization Factor (m^3/kg)	Dermal Absorption Fraction	GI Absorption Fraction	Oral Slope Factor $(mg/kg\text{-}day)^{-1}$	Source	Inhalation Unit Risk (ug/m^3)	Source	Oral Reference Dose (mg/kg-day)	Source	Inhalation Reference Concentration (RfC) (mg/m^3)	Source
Aluminum	7429-90-5	--	1.0E-03	--	--	1	--	--	--	--	1.0E+00	P	5.0E-03	P
Antimony	7440-36-0	--	1.0E-03	--	--	0.15	--	--	--	--	4.0E-04	I	--	--
Arsenic	7440-38-2	--	1.0E-03	--	0.03	1	1.5E+00	I	4.3E-03	I	3.0E-04	I	1.5E-05	C
Barium	7440-39-3	--	1.0E-03	--	--	0.07	--	--	--	--	2.0E-01	I	5.0E-04	H
Beryllium	7440-41-7	--	1.0E-03	--	--	0.007	--	--	2.4E-03	I	2.0E-03	I	2.0E-05	I
Cadmium (Diet)	7440-43-9	--	1.0E-03	--	0.001	0.025	--	--	1.8E-03	I	1.0E-03	I	2.0E-05	A
Cadmium (Water)	7440-43-9	--	1.0E-03	--	0.001	0.05	--	--	1.8E-03	I	5.0E-04	I	2.0E-05	A
Chromium, Total	7440-47-3	--	1.0E-03	--	--	0.013	--	--	--	--	--	--	--	--
Chromium (III)	16065-83-1	--	1.0E-03	--	--	0.013	--	--	--	--	1.5E+00	I	--	--
Chromium (VI)	18540-29-9	M	2.0E-03	--	--	0.025	5.0E-01	J	8.4E-02	S	3.0E-03	I	1.0E-04	I
Cobalt	7440-48-4	--	4.0E-04	--	--	1	--	--	9.0E-03	P	3.0E-04	P	6.0E-06	P
Copper	7440-50-8	--	1.0E-03	--	--	1	--	--	--	--	4.0E-02	H	--	--
Iron	7439-89-6	--	1.0E-03	--	--	1	--	--	--	--	7.0E-01	P	--	--
Manganese (Diet)	7439-96-5	--	1.0E-03	--	--	1	--	--	--	--	1.4E-01	I	5.0E-05	I
Manganese (Non-diet)	7439-96-5	--	1.0E-03	--	--	0.04	--	--	--	--	2.4E-02	S	5.0E-05	I
Mercury	7439-97-6	--	1.0E-03	--	--	0.07	--	--	--	--	3.0E-04	I	3.0E-04	S
Methylmercury	22967-92-6	--	1.0E-03	--	--	1	--	--	--	--	1.0E-04	I	--	--
Molybdenum	7439-98-7	--	1.0E-03	--	--	1	--	--	--	--	5.0E-03	I	--	--
Nickel	7440-02-0	--	2.0E-04	--	--	0.04	--	--	2.6E-04	C	2.0E-02	I	9.0E-05	A
Aroclor 1260	11096-82-5	--	9.9E-01	--	0.14	1	2.0E+00	S	5.7E-04	S	--	--	--	--
Acenaphthene	83-32-9	--	8.6E-02	1.51E+05	0.13	1	--	--	--	--	6.0E-02	I	--	--
Anthracene	120-12-7	--	1.4E-01	5.63E+05	0.13	1	--	--	--	--	3.0E-01	I	--	--
Benz(a)anthracene	56-55-3	M	5.5E-01	--	0.13	1	7.3E-01	E	1.1E-04	C	--	--	--	--
Benzo(a)pyrene	50-32-8	M	7.1E-01	--	0.13	1	7.3E+00	I	1.1E-03	C	--	--	--	--
Benzo(b)fluoranthene	205-99-2	M	4.2E-01	--	0.13	1	7.3E-01	E	1.1E-04	C	--	--	--	--
Benzo(k)fluoranthene	207-08-9	M	6.9E-01	--	0.13	1	7.3E-02	E	1.1E-04	C	--	--	--	--
Chrysene	218-01-9	M	6.0E-01	--	0.13	1	7.3E-03	E	1.1E-05	C	--	--	--	--
Dibenz[a,h]anthracene	53-70-3	M	9.5E-01	--	0.13	1	7.3E+00	E	1.2E-03	C	--	--	--	--
Fluoranthene	206-44-0	--	3.1E-01	--	0.13	1	--	--	--	--	4.0E-02	I	--	--
Fluorene	86-73-7	--	1.1E-01	3.03E+05	0.13	1	--	--	--	--	4.0E-02	I	--	--
Indeno[1,2,3-cd]pyrene	193-39-5	M	1.0E+00	--	0.13	1	7.3E-01	E	1.1E-04	C	--	--	--	--
2-Methylnaphthalene	91-57-6	--	9.2E-02	6.24E+04	0.13	1	--	--	--	--	4.0E-03	I	--	--
Naphthalene	91-20-3	--	4.7E-02	4.99E+04	0.13	1	--	--	3.4E-05	C	2.0E-02	I	3.0E-03	I
Pyrene	129-00-0	--	2.0E-01	2.56E+06	0.13	1	--	--	--	--	3.0E-02	I	--	--
Selenium	7782-49-2	--	1.0E-03	--	--	1	--	--	--	--	5.0E-03	I	2.0E-02	C
Silver	7440-22-4	--	6.0E-04	--	--	0.04	--	--	--	--	5.0E-03	I	--	--
Thallium	7440-28-0	--	1.0E-03	--	--	1	--	--	--	--	1.0E-05	X	--	--
Vanadium	7440-62-2	--	1.0E-03	--	--	1	--	--	--	--	5.0E-03	S	1.0E-04	A
Zinc	7440-66-6	--	6.0E-04	--	--	1	--	--	--	--	3.0E-01	I	--	--

Notes:
CASRN = Chemical Abstract System Registry Number

Sources:
A - Agency for Toxic Substances and Disease Registry (ATSDR)
C - California Environmental Protection Agency (CAEPA)
E - Environmental Criteria and Assessment Office (ECAO)
H - Health Effects Assessment Summary Tables (HEAST)
I - Integrated Risk Information System (IRIS)
S = RSL user guide Section 5
P - Provisional Peer-Reviewed Toxicity Values (PPRTV)
X - PPRTV Appendix

Notes (continued):

Kp values from the EPA Estimation Program Interface (EPI) Suite database.
EPA Nov 2012 regional screening levels (RSLs) and volatilization factors (VFs).
Cancer slope factors and inhalation unit risks (IURs) for carcinogenic polynuclear aromatic hydrocarbons (PAHs) were weighted according to their respective benzo(a)pyrene toxicity equivalency factors (TEFs) using the scheme of EPA's *Provisional Guidance for Quantitative Risk Assessment of Polycyclic Aromatic Hydrocarbons* (EPA, 1993a).

m^3/kg = cubic meters per kilogram; mg/kg = milligrams per kilogram; ug/m^3 = micrograms per cubic meter; mg/m^3 = milligrams per cubic meter

TABLE 8
Assessment and Measurement Endpoints for the Ecological Risk Assessment
Risk Assessment Work Plan, Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Functional Group	Assessment Endpoint	Representative Endpoint Species	Measure of Exposure	Measure of Effect
Aquatic Organisms	Survival and health of freshwater and marine/estuarine aquatic organisms using water bodies at or down-gradient of Salt Chuck Mine, and potentially exposed to constituents in surface water and prey items	Freshwater and marine fish, amphibians, and aquatic invertebrates	Measured constituent levels in surface water	Federal and state water quality criteria/standards
Benthic and Epibenthic Organisms	Survival and health of benthic and epibenthic organisms using water bodies at and down-gradient of Salt Chuck Mine, and potentially exposed to constituents in sediment	Benthic macroinvertebrates, clams and other shellfish	Measured constituent levels in sediment and shellfish tissue; exposure levels used during sediment bioassay testing.	Freshwater (for example, TECs and PECs) and marine sediment (for example, ER-Ms and AETs) benchmarks from literature, tissue-residue effects levels from literature, and site-specific sediment bioassay results
Terrestrial Invertebrates	Survival and health of terrestrial invertebrates at and down-gradient of Salt Chuck Mine, and potentially exposed to constituents in soil	Terrestrial invertebrates	Measured constituent levels in soil	Terrestrial invertebrate benchmarks from literature (for example, Eco SSLs)
Herbivorous Birds	Survival and health of herbivorous birds using areas with suitable habitat, and potentially exposed to constituents in surface water, soil/sediment and forage items	Spruce grouse (upland/riparian), mallard (intertidal)	Measured constituent levels in surface water, soil/sediment, plant tissue	Literature-based chronic LOAEL for bird populations and NOAEL for T&E species*
Carnivorous bird)	Survival and health of carnivorous birds using areas with suitable habitat, and potentially exposed to constituents in surface water, soil and prey items	Northern shrike (upland)	Measured constituent levels in surface water and soil; modeled constituent levels in food items	Literature-based chronic LOAEL for bird populations and NOAEL for T&E species*
Omnivorous Birds	Survival and health of omnivorous birds using areas with suitable habitat, and potentially exposed to constituents in surface water, soil and forage items	Chestnut-backed chickadee (upland)	Measured constituent levels in surface water, soil, and plant tissue; modeled constituent levels in food items	Literature-based chronic LOAEL for bird populations and NOAEL for T&E species*
Insectivorous Birds	Survival and health of insectivorous birds using areas with suitable habitat, and potentially exposed to constituents in soil/sediment and prey items	Common snipe (riparian), western sandpiper (intertidal)	Measured constituent levels in soil/sediment; modeled constituent levels in food items	Literature-based chronic LOAEL for bird populations and NOAEL for T&E species*
Piscivorous Birds	Survival and health of piscivorous birds using areas with suitable habitat, and potentially exposed to constituents in surface water, sediment and prey items	Belted kingfisher (intertidal)	Measured constituent levels in surface water, sediment and shellfish tissue	Literature-based chronic LOAEL for bird populations and NOAEL for T&E species*
Carnivorous Mammals	Survival and health of carnivorous mammals using areas with suitable habitat, and potentially exposed to constituents in surface water, soil and prey items	Gray wolf (upland)	Measured constituent levels in surface water and soil; modeled constituent levels in food items	Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species*

TABLE 8

Assessment and Measurement Endpoints for the Ecological Risk Assessment

Risk Assessment Work Plan, Remedial Investigation, Salt Chuck Mine, Tongass National Forest, Alaska

Functional Group	Assessment Endpoint	Representative Endpoint Species	Measure of Exposure	Measure of Effect
Herbivorous Mammals	Survival and health of herbivorous mammals using areas with suitable habitat, and potentially exposed to constituents in surface water, soil and forage items	Sitka black-tailed deer (upland)	Measured constituent levels surface water, soil, and plant tissue	Literature-based chronic LOAEL for mammal populations and NOEAL for T&E species*
Omnivorous Mammals	Survival and health of omnivorous mammals using areas with suitable habitat, and potentially exposed to constituents in surface water, soil/sediment, and prey/forage items	Black bear (upland/intertidal)	Measured constituent levels in surface water, soil, plant tissue; modeled constituent levels in prey items	Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species*
Insectivorous Mammals	Survival and health of insectivorous mammals using areas with suitable habitat, and potentially exposed to constituents in surface water, sediment and prey items	Northern water shrew (riparian)	Measured constituent levels in surface water, sediment; modeled constituent levels in food items	Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species*
Piscivorous Mammals	Survival and health of piscivorous mammals using areas with suitable habitat, and potentially exposed to constituents in surface water, sediment and prey items	Mink (intertidal)	Measured constituent levels in surface water, sediment and shellfish tissue	Literature-based chronic LOAEL for mammal populations and NOAEL for T&E species*
Terrestrial, Riparian and Intertidal Vegetation	Survival and health of plants within the Salt Chuck Mine area, and potentially exposed to constituents in soil/sediment	Various Plants	Measured constituent levels in soil/sediment	Available plant benchmarks from literature sources

Notes:

* = As described in Section 2.3.4, no T&E species are expected to use the Salt Chuck Mine site and therefore, will not be evaluated as part of this ERA. If T&E species are identified during the RI, then they will be addressed in the ERA.

NOAEL = no observed adverse effect level
LOAEL = lowest observed adverse effect level
TEC = threshold effect concentration (MacDonald et al., 2000)
PEC = probable effect concentration (MacDonald et al., 2000).
ER-M = effects range-median (Long and Morgan, 1990)
AET = apparent effects threshold (Buchman, 2008)
Eco SSL = EPA's Ecological Soil Screening Level (Long and Morgan, 1990)

Table 9

Exposure Factors for Bird and Mammal Endpoint Species

Remedial Investigation, Salt Chuck Mine – Tongass National Forest, Alaska

Risk Assessment Work Plan

Assessment Endpoint Functional Group	Endpoint Species	Body Weight (kg)	Source	Food Intake[1] (kg/kg-bw/d, dw)	Water Intake[2] (L/kg-bw/d)	Migration Factor[4]	Home Range (acres)	Source	Assumed Diet Composition: % of Diet as Mammals/ Birds	% Diet as Terrestrial Invertebrates	% Diet as Aquatic Invertebrates	% of Diet as Plants	% of Diet as Fish/ Shellfish	% of Diet as Soil/ Sediment	Surrogate for % of Diet as Soil/Sediment	Source
Herbivorous birds	Spruce Grouse	0.525	Cornell, 2013	0.094	0.073	1	521	USFWS 2010	0	0	0	100	0	9.3	Wild turkey	Beyer, 1994
Herbivorous birds	Mallard	1.16	USEPA, 1993	0.609	0.056	1	1433	EPA 1993	0	0	8	92	0	3.3	---	Beyer, 1994
Omnivorous birds	Chestnut-backed Chickadee	0.0115	ADFG, 2013a	2.595	0.258	1	3.3	Zeiner et al., 1990	0	80	0	20	0	2	2% for omnivores	Beyer, 1994
Insectivorous birds	Western Sandpiper	0.028	Cornell, 2013	1.192	0.192	1	0.62	EPA 1993 (Spotted Sandpiper surrogate)	0	0	100	0	0	18	---	Beyer, 1994
Carnivorous birds	Northern Shrike	0.0675	Cornell, 2013	2.106	0.144	1	11	Zeiner et al., 1990 (Loggerhead Shrike surrogate)	100	0	0	0	0	0.7	Bald Eagle	Pascoe et al., 1996
Piscivorous birds	Belted Kingfisher	0.155	Cornell, 2013	1.591	0.109	1	2.50	EPA 1993	0	0	0	0	100	0.7	Bald Eagle	Pascoe et al., 1996
Herbivorous mammals	Sitka black-tailed deer	45.4	ADFG, 2013b	0.208	0.068	1	145	Sample et al., 1997	0	0	0	100	0	<0.2	Mule deer	Beyer, 1994
Omnivorous mammals	Black bear	86.2	ADFG, 2013b	0.103	0.063	1	6400	NPS, 2013	50[3]	0	0	50	50[3]	9.4	Raccoon	Beyer, 1994
Insectivorous mammals	Dusky shrew	0.007	Olori, 2005	2.434	0.163	1	0.96	EPA 1993 (short-tailed shrew surrogate)	0	100	0	0	0	2.4	Meadow vole	Beyer, 1994
Carnivorous mammals	Gray wolf	45.4	ADFG, 2013b	0.081	0.068	1	83,200	Montana Field Guide, 2013	80	0	0	0	20	2.8	Red fox	Beyer, 1994
Piscivorous mammals	Mink	0.852	USEPA, 1993	0.157	0.101	1	554	EPA 1993	0	0	0	0	100	9.4	Raccoon	Beyer, 1994

Notes:

[1] = Nagy (2001) regression equation for food ingestion rate (grams dry matter ingested/day/gram body weight = (a x BW^{b})/BW; Note: values for a and b are presented below

[2] = The allometric equations provided in Calder and Braun (1983) as cited in Sample et. al. (1997) were used to estimate daily water ingestion rates for each receptor species, as follows:

- Water ingestion rate for all birds (L/day) = $(0.059 * BW^{0.67})$/BW
- Water ingestion rate for all mammals (L/day) = $(0.099 * BW^{0.90})$/BW

BW = body weight

DW = dry weight

TBD = to be determined through additional literature research

[3] = Assumes 50% birds and mammals and 50% terrestrial plants for upland exposure scenario; assumes 50% fish/shellfish and 50% aquatic plants for intertidal exposure scenarios

[4] = Initially assumed to be present 100% of the year

EPA = United States Environmental Protection Agency

Group	***a***	***b***	
Birds			
Passerines	0.630	0.683	Chickadee
All Birds	0.638	0.685	Mallard
Galliformes	0.088	0.891	Grouse
Charradriiformes	0.522	0.769	Sandpiper
Carnivorous birds	0.849	0.663	Shrike, Kingfisher
Mammals			
Herbivorous mammals	0.859	0.628	Deer
Omnivorous mammals	0.432	0.678	Bear
Insectivorous mammals	0.373	0.622	Shrew
Carnivorous mammals	0.153	0.834	Wolf, Mink

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